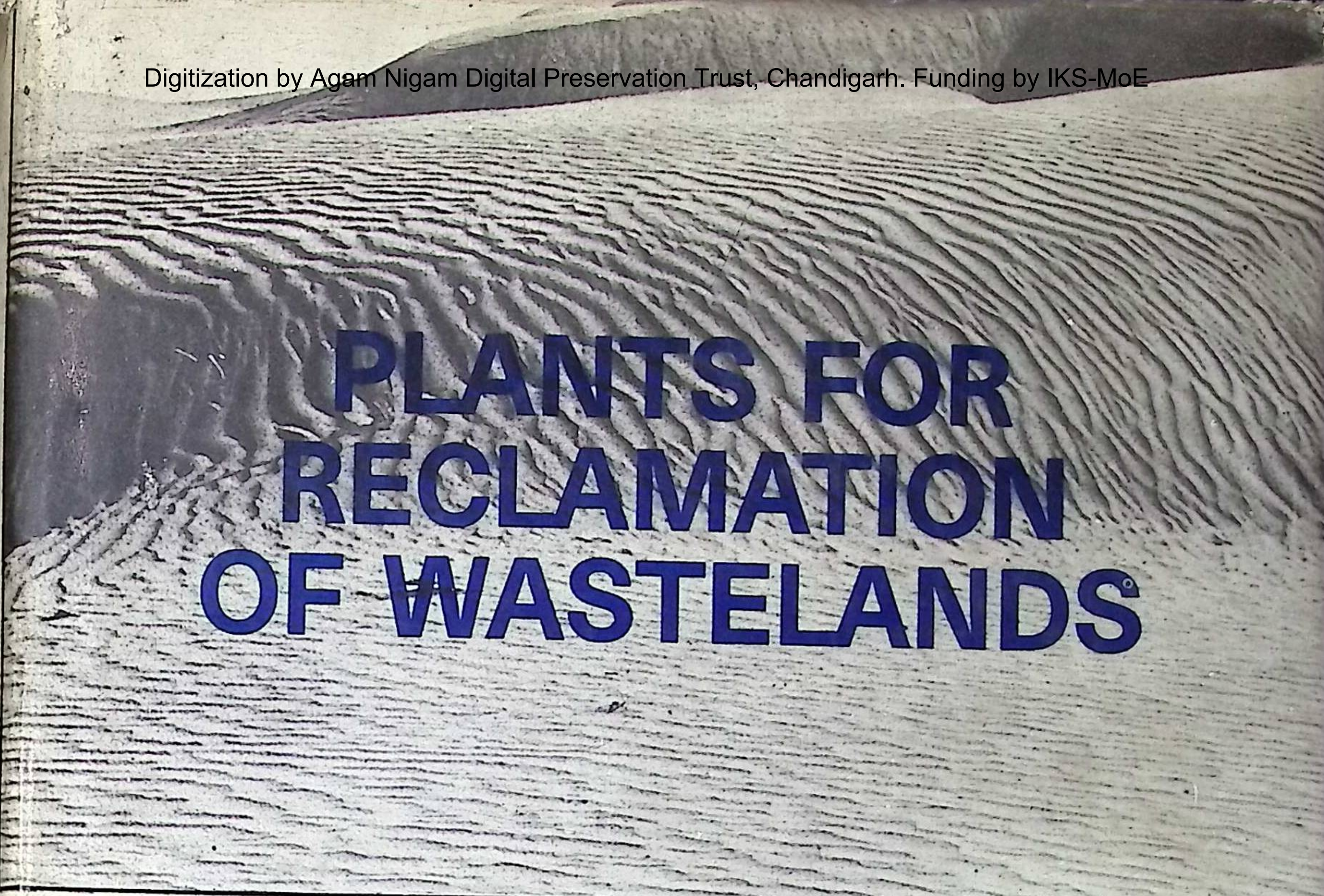
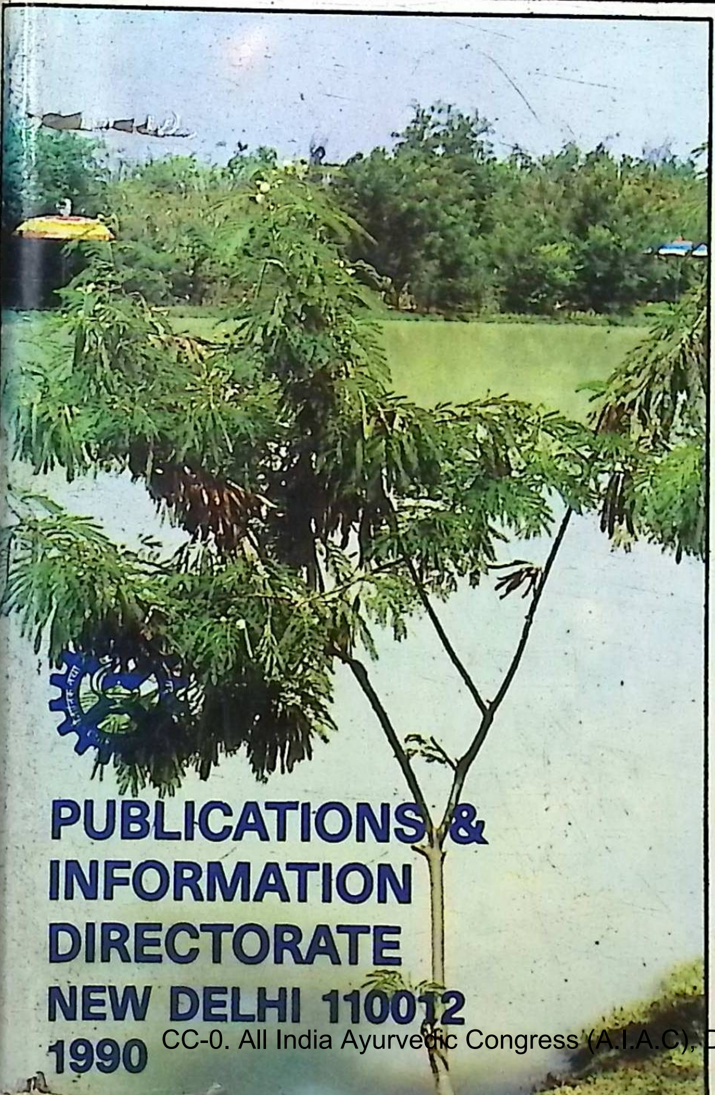


PLANTS FOR RECLAMATION OF WASTELANDS



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Advancing desertification, caused by environmental degradation, such as deforestation, soil-erosion, salinization and flooding, has become a global concern. The intimate association between plants and animals and their interaction with soil make the soil dynamic and enrich it with nutrients; and these keep desertification at bay.

India possesses about 175-million hecatres of wastelands or wasted lands. Phased reclamation of these lands may not only improve the soil but meet the requirement of food, fodder, fuel and timber and other economic products. Several reclamation programmes have been launched by the Government, voluntary organizations and international agencies, but they are insufficient to meet the problem of such a magnitude.

This book describes briefly various types of wastelands, their characteristics, causes, the importance of green cover, role of nitrogen-fixing plants and energy-crops, and other related issues. Keeping in view the growing need for timber, fuel and fodder, this book attempts to bring together information on as many wild or not-so-wild plants as possible, which, besides being useful in reclamation, also yield other economic products.

Out of the 1003 species dealt with, the major ones are described in their alphabetical order with emphasis on reclamation. The minor species are given in a Table. Classified lists of plants according to their suitability for the different types of wastelands and also according to their economic value are provided A short account on the reclamation of mined wastelands is also included.

An indispensible book for those concerned with environment, ecology, reclamation and afforestation; also useful for researchers and planners.

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PLANTS FOR RECLAMATION OF WASTELANDS

PLANTS FOR RECLAMATION OF WASTELANDS

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Council of Scientific & Industrial Research
New Delhi
1990

Director: Dr G P Phondke
Project-Coordinator: Mrs K Ramachandran

Editors

Tenjarla C S Sastry
K Y Kavathekar
with the assistance of

B Subramaniam	O J Chakre
K K Kakkar	P K Panda
N R Mankad	Sunita Garg

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FOREWORD

Less than half of the land-mass of India is cultivated, of which again nearly half is degraded, having lower productivity than its potential. A large area of the country has become unproductive due to several factors such as soil-erosion, excess salinity and alkalinity, waterlogging, shifting-cultivation, etc. Pressure of the increasing human and livestock populations, combined with unscientific cultivation and deforestation over the years, has led to a serious environmental crisis. Rectification of this situation calls for steps to preserve and further improve the green cover so essential for human well-being. The need of the hour is to bring about a greater awareness amongst policy-makers and intensify research effort and its extension to find suitable methods to improve degraded lands and encourage the creation of various types of forests, by the institutions of the Central and State Governments. A part of this unproductive land is culturable and can be utilized through proper scientific and technological inputs. This would also improve the environment and restore ecological balance.

Some of the science-and-technology inputs aim at economic utilization of problematic soils by cultivation of aromatic grasses. These grasses can be grown even on marginal soils with good economic return. Biomass production and standardization of economic agro-technologies can rejuvenate the marginal (*usar*) lands. Coastal sand-dunes in semi-arid Gujarat and semi-humid Orissa pose challenges for their economic use. Along the coastlines of India, mangrove trees are economically attractive and also protect the shoreline from erosion. These fragile and sensitive ecosystems have been abused, over exploited and neglected. Mangroves face cosntant deforestation and marine pollution which, in turn, affect coastal fisheries.

The basic requirement for the development of wastelands is the creation of a suitable vegetative cover which not only prevents further degradation but improves the environment. The green cover can be created through different types of plants which can also meet the requirement of timber, fuel, fodder, food, fruit, etc. Monoculture fails to meet the above requirements and leads to further degradation, disturbing the delicate balance of nutrients in the soil. Besides, it upsets the ecological balance, through diseases and pests.

All plants have a role to play in the biotic community. Certain plants have a specific role in the ecosystem. For example, grasses and many other herbs produce large quantities of seed in a short span of life and provide the green base for the growth of other plants. The grasses along with other plant species, having elaborate root-systems and trailing rhizomes, sometimes extending up to two metres, prevent erosion. The roots of these plants form mats underground and considerably reduce both water- and wind-induced erosion. This keeps the topsoil intact and conserves the moisture content, thereby improving the overall texture of the soil. Grasses provide mulch, collect and protect the seeds of other plants, and encourage their growth. Besides improving the ecosystem, they provide fodder.

Shrubs and trees are needed to reduce erosion. By cushioning the impact of the raindrops they reduce erosion, improve seepage and increase the moisture content of the soil. As the water does not drain away quickly, the subterranean watertable is raised. Shrubs and trees also help in decreasing the effect of wind-velocity thereby curtailing sand-drifts.

India has a large and varied indigenous flora which is suitable for various types of wastelands. It is necessary to identify multipurpose indigenous species which can meet specific climatic and soil conditions. The selected species should have a fast rate of growth, be capable of improving the environment and soil and conserve moisture, and also have requisite thermal efficiency. In view of the continuing demand for fuelwood, there is a need to increase the cultivation of different types of biomass under various agro-climatic conditions.

The local flora may be given preference in reclamation. These plants become the earliest colonizers and create conditions favourable for the establishment of the succeeding group of plants. Many such indigenous or naturalized plants of economic utility are suitable for various soils; from deserts to cold regions, saline and alkaline soils, sandy, arid regions and waterlogged areas. These have been identified and included in this compendium. A brief account on the development of wastelands with nitrogen-fixing plants and energy-crops is also included. It is hoped that this scientific information will be used by all concerned agencies and groups to launch a concerted effort to understand the factors responsible for degraded lands and join in the crusade to recreate vegetative alternatives to make wastelands cultivable.

(RAM K. IYENGAR)
Additional Director-General
Council of Scientific & Industrial Research

August 1990
New Delhi

PREFACE

Indiscriminate destruction of green cover and unscientific practices of cultivation over the years have resulted in rapid erosion of topsoil and ultimately converted cultivable lands to wastelands. These wastelands can, with inputs, be utilised for producing food, fodder, timber, and other vegetable products. The most economic method of reclamation is to have a green cover. The natural processes are time-consuming and the present situation demands green cover through quick-growing species which can also provide much-needed timber, fuel and fodder.

In the recent past, exotic species have been introduced for reclaiming wastelands, but many of them took much more time for establishing than expected. The indigenous flora has not been explored to the extent it should have been. The indigenous flora is easy and quick to establish, and attention has already been drawn to these factors. Efforts have recently been made to select such indigenous species or naturalized exotic species as are suitable for various soils and also possess fast rate of growth, need less inputs, and improve soil and environment. Already many species of *Acacia*, *Albizia*, *Alnus*, *Leucaena*, *Parkinsonia*, *Populus*, *Prosopis*, *Salix*, etc. have been included in various programmes of reclamation. Though an attempt has been made to include a wide variety of useful species in this book, the list is by no means complete or exhaustive.

The selected plants have been grouped into two : (1) Major — discussed in detail and arranged in alphabetical sequence, and (2) Minor — discussed in brief and arranged alphabetically in a tabular form. Bamboos and *Eucalyptus* needed special treatment. Brief accounts on the role of nitrogen-fixing plants and energy- crops in reclamation have been given. Also, a brief chapter on 'Development of Mined Wastelands' is included.

As many illustrations as possible have been included. The bibliography provided is not exhaustive. The Wealth of India — Raw Materials Series was extensively searched and the bibliography before the dates of these publications was not referred to unless warranted. An attempt has been made to select as far as possible one common name in each Indian language, though many names are available. The Wealth of India — Raw Materials Series may be referred to for more names, if necessary. The abbreviations followed in the text are very common.

At the end, lists of plants suitable for reclaiming various problematic soils and yielding timber, fuel, fodder, etc., discussed in the text, have been appended for quick reference.

This publication should be able to meet the basic requirement of providing a guide for selecting plants by any one who is interested in reclamation work. This publication was initiated under the guidance of Mr S P Ambasta, *ex* Editor-in-Chief. Mrs K Ramachandran, Project Coordinator, Wealth of India, had given us valuable suggestions from time to time during the preparation of manuscript. We are grateful for their constant encouragement and guidance.

We record our sincere appreciation for the wholehearted cooperation of the Art-and-Graphic Section, Computer Division and the Photocomposing-*cum*-Printing Unit of this Directorate in the execution of this work.

Thanks are due to Dr M V Viswanathan and Dr H B Singh for their assistance. Thanks are also due to Mr N A Sukhapure for processing the illustrations, Mr B R Chauhan for photographic assistance, Mrs Sushila Vohra for the cover-design, Mr K K Bahuguna for typing and Mr Kali Charan for xeroxing. We also thank the help rendered by Mrs K S Bagchi, Librarian, Society for Promotion of Wastelands Development, New Delhi, in procuring information from some sources beyond our reach. We have written to some authors and publishers for permission for utilizing a few illustrations. Necessary acknowledgement has been given elsewhere.

Last but not least, we thank Dr G P Phondke, Director, PID, for his constant encouragement in completing this work.

September 1990
New Delhi

Tenjarla C S Sastry
K Y Kavathekar

LIST OF COLOURED ILLUSTRATIONS

Deep ravines —SPWD
Mangroves —NWDB
Degraded hills —SPWD
Waterlogged area with *Typha* sp. — T P Sirisha
Mixed shelterbelt on drylands *Acacia auriculaeformis* and *A. holosericea* — PHCC–NWDB
Social forestry — *Eucalyptus* planting on field-bunds — SFWG –NWDB
Salt-affected land — T P Sirisha
Destruction of forest on the hills for crops — PHCC–NWDB
Destruction of catchment area — PHCC–NWDB
Degraded grazing-lands — NWDB
Rocky degraded plains — NWDB
Sandy area and its reclamation — NWDB
Strip-land — *Parkinsonia aculeata* as shelterbelt — NWDB
Mixed plantation — PHCC–NWDB
Acacia nilotica — Planting on tankbed — PHCC–NWDB
Acacia nilotica — NLC
Acacia auriculaeformis — NLC
Acacia leucophloea — SPWD
Agave mexicana —NLC
Albizia lebbeck —NLC
Anacardium occidentale —NLC
Azadirachta indica — Plantings on red, rocky soil — BAIF–NWDB
Borassus flabellifer — Shelterbelts for agricultural land — PHCC–NWDB
Casuarina equisetifolia — SPWD
Cassia siamea — BAIF–NWDB
Ceiba pentandra — NLC
Erythrina indica; Shoots with red and white flowers — T P Sirisha
Euphorbia nivulea — IIP
Euphorbia antiquorum — IIP
Dalbergia sissoo — NLC
Dendrocalamus strictus — NLC
Hemidesmus indicus — IIP

Euphorbia antisyphilitica — IIP
Eucalyptus Hybrid — NLC
Euphorbia royleana — PID
Euphorbia trigona — IIP
Ipomoea pes-capre -– NLC
Jatropha curcas — IIP
Grevillea robusta — NLC
Leucaena latisiliqua on tank-shore — NLC
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Tamarindus indica — NLC
Samanea saman — NLC
Lagerstroemia speciosa — NLC
Tamarix sp and *Saccharum* sp on salt-affected soils — T P Sirisha
Parkinsonia aculeata — NLC
Simmondsia chinensis—male flowers; Shoot with female flowers; Fruit (Kelley Dwyer — JAOCS)
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Consolidation of ash-slope of lignite with various species — NLC
Reclaiming minespoils through hydroseeding — NLC
Reclamation of dumping-yard in lignite mines — NLC
Man-made forests on lignite-spoils and creation of waterbodies — NLC

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INTRODUCTION

Part I

INDIA

Boundaries

India, the seventh largest and the second most-populated country, is located in a southern sub-continental peninsula in the Northern Hemisphere between 8°4' and 37°6' N and 68°7' and 97°25' E. Its boundaries are well-marked off from the rest of Asia by the Himalayas and the sea. The land-frontier is *c* 15,200 km, and the coastline of the mainland, and the Lakshadweep and the Andaman and Nicobar groups of Islands is 7516.6 km. The country covers an area of 3,287,263 sq km* .

The mainland is divided into the great zone of mountains, the Indo-Gangetic plains, the desert region and the southern peninsula. The Himalayas and several other mountains still maintain considerable green cover; the higher reaches of the Himalayas are covered with glaciers and snow. They are the sources of the major rivers of northern India. The Indo-Gangetic plains, *c* 2400-km long and 240–320-km broad, mostly formed by the Indus, the Ganga and the Brahmaputra river-systems, are one of the greatest stretches of flat alluvium and also one of the most densely populated areas in the East. The desert, lying between the Rann of Kachchh, Rajasthan–Sindh frontier and Jaisalmer and Jodhpur up to the northern wastes, can be divided into The Great Indian Desert and The Little Desert, comprising almost absolutely sterile country due to the absence of surface-water and very scanty rainfall, and rockland cut up by limestone ridges.

Most of the land-surface in India has developed a plateau character. The Malwa and Vindhyan Plateaux, the Baghelkhand Plateau and the Palamau Plateau and Chota Nagpur Plateau are important above the Vindhyas. The peninsula in the South comprises the Deccan Plateau, flanked by the Eastern and Western Ghats, with a very wide coastal area—the Coromandel Coast—in the East, and the narrow coastal area—the Konkan and Kerala—in the West. Some stretches of the ghats are still covered with very good green cover and at some places it is unique as in the Silent Valley; the ghats are the source for the peninsular rivers.

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*Provisional as on 31.3.1982 (India, 1986)

The plains cover more than a million square kilometres. They are lush-green with vegetation and densely populated at water-sources. Most of the Himalayan rivers and their tributaries have built up the plains. The mountain-plains are lacustrine and glacial in nature. There are plains at the foot of Himalayas, such as piedmont plains. On the West of Aravalli, there are rocky, arid plains. Lava-plains occur on the Konkan coast. Pediplains in South India and the Coastal plains of emergent type with lagoons and backwaters constitute the rest.

Soils

The soils may be classified mainly under four different heads: (*1*) alluvial, (*2*) black, (*3*) red, and (*4*) laterite and lateritic soils. Further, these are classified into 25 groups by the Ministry of Agriculture & Rural Development (Table 1).

River-systems

Most of the rivers originate in the watershed areas. The annual total discharge is estimated at *c* 1, 683, 000-million m^3. The Himalayan rivers are generally snowfed with reasonable flow throughout the year. The peninsular rivers are rainfed and, therefore, fluctuate in volume and have formed the coastal deltas. The coastal streams, especially on the west coast, are short and mostly flashy. The streams of the inland-drainage basin of West Rajasthan are very few and ephemeral, draining towards the individual basins or saltlakes, such as the Sambhar, or are lost in the sands. Only the river Luni drains into the Rann of Kachchh.

Climate

Since India stretches from the high Himalayas to the tropical seas, various climatic zones are found in the sub-continent. Parts of North India have severe winters and hot summers, whereas the South has a mild winter or none at all. Hence, the climate can broadly be described as tropical-monsoonal type.

Temperature

Depending upon the altitudinal differences, the temperatures differ.

TABLE 1—AREA UNDER BROAD GROUPS OF SOIL

Major Soil-group	Area (million ha)	Percentage to total geographical area
Red Loamy	23.0	7.01
Red Sandy	49.0	14.9
Laterite	11.7	3.6
Red & Yellow	33.5	10.2
Shallow Black	6.5	2.0
Medium Black	41.7	12.7
Deep Black	16.2	4.9
Mixed Red & Black	14.8	4.5
Coastal Alluvium	6.2	1.9
Coastal Sand	1.1	0.3
Deltaic Alluvium	7.1	2.2
Alluvial—Recent	39.0	11.9
Calcareous Alluvium	2.2	0.7
Calcareous Sierozem	4.9	1.5
Old Alluvium	2.8	0.9
Grey-brown	8.9	2.7
Desert-soils—Regosolic	13.4	4.08
Desert-soils—Lithosolic	8.5	2.6
Terai	3.1	0.9
Brown Hill	12.4	3.8
Sub-mountane	4.7	1.4
Mountain Meadow	6.6	2.01
Peaty and Saline Peaty	0.4	0.1
Skeletal	4.2	1.3
*Saline & Alkaline	—	—

*Included into the areas under different groups of soils.
Source : *Indian Agriculture in Brief*, 1986.

The higher reaches of Himalayas, such as Ladakh, have sub-zero temperatures and the coastal areas or slightly interiors have up to 48°–49°C, whereas the plateaux are generally cooler.

Rainfall

The rainfall is erratic and ill-distributed and varies from year to year and from place to place. The highest rainfall (more than 2000 mm annually) is received on the west coast, in West Bengal, and Assam and the neighbourhood, Cherrapunji receiving the maximum of 11,419 mm. In contrast, the rainfall in Rajasthan, Kachchh and from the high Ladakh Plateau to Gilgit ranges between 100 and 500 mm. The major part of the country receives a rainfall of 1000–2000 mm or 500–1000 mm. Whereas most parts of the country receive rain during June–September from the South-West mon-

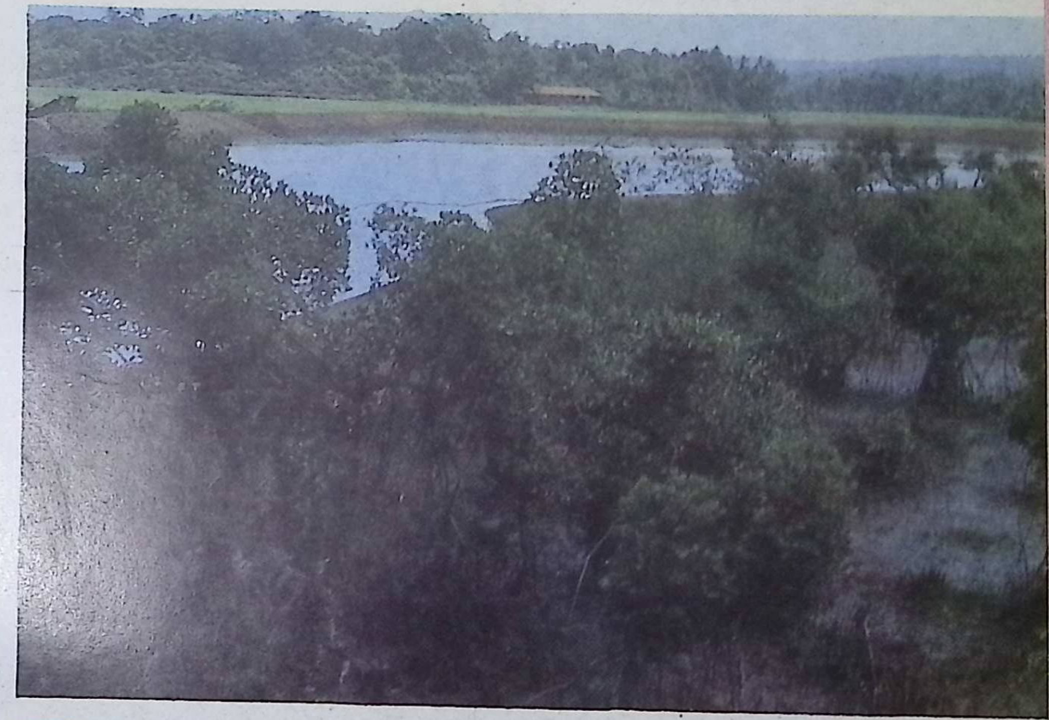
TABLE 2—LANDUSE CLASSIFICATION DURING 1950–83
(million ha)

Item	1950–51	1960–61	1970–71	1975–76	1978–79	1979–80	1980–81	1981–82	1982–83
Area under forests	40,482 (14.2)	54,052 (18.1)	63,917 (21.0)	66,701 (21.9)	67,468 (22.1)	67,480 (22.2)	67,421 (22.2)	67,416 (22.1)	67,161 (22.1)
Area not available for cultivation	47,517 (16.7)	50,751 (17.0)	44,640 (14.7)	40,276 (13.2)	39,346 (12.9)	39,607 (13.0)	39,643 (13.0)	39,729 (13.1)	39,721 (13.0)
(*i*) Area under non-agricultural uses	9,357 (3.3)	14,840 (5.0)	16,479 (5.4)	17,431 (5.7)	19,083 (6.3)	19,337 (6.3)	19,477 (6.4)	19,506 (6.4)	19,582 (6.4)
(*ii*) Barren & unculturable land	38,160 (13.4)	35,911 (12.0)	28,161 (9.3)	22,845 (7.5)	20,263 (6.6)	20,270 (6.7)	20,166 (6.6)	20,223 (6.7)	20,139 (6.6)
Other uncultivated land (excluding fallow-land)	49,446 (17.4)	37,637 (12.6)	35,060 (11.6)	33,936 (11.2)	33,021 (10.9)	32,299 (10.6)	32,195 (10.6)	32,083 (10.5)	31,823 (10.5)
(*i*) Permanent pasture & other grazing-land	6,675 (2.3)	13,966 (4.7)	13,262 (4.4)	12,589 (4.2)	12,134 (4.0)	12,100 (4.0)	12,007 (3.9)	12,050 (3.9)	11,956 (3.9)
(*ii*) Land under misc. tree-crops & groves not included in net area sown	19,828 (7.0)	4,459 (1.5)	4,298 (1.4)	3,991 (1.3)	3,578 (1.2)	3,513 (1.1)	3,489 (1.2)	3,623 (1.2)	3,554 (1.2)
(*iii*) Culturable wastelands	22,943 (8.1)	19,212 (6.4)	17,500 (5.8)	17,356 (5.7)	17,309 (5.7)	16,686 (5.5)	16,699 (5.5)	16,410 (5.4)	16,313 (5.4)
Fallow-lands	28,124 (9.9)	22,819 (7.7)	19,357 (6.4)	21,847 (7.2)	21,837 (7.2)	25,727 (8.5)	24,609 (8.1)	23,049 (7.6)	23,636 (7.8)
(*i*) Fallow-lands other than current fallows	17,445 (6.1)	11,180 (3.8)	8,759 (2.9)	9,381 (3.1)	9,366 (3.1)	10,005 (3.3)	9,794 (3.2)	9,563 (3.2)	9,503 (3.1)
(*ii*) Current fallows	10,679 (3.8)	11,639 (3.9)	10,598 (3.5)	12,466 (4.2)	12,471 (4.1)	15,722 (5.2)	14,815 (4.9)	13,486 (4.4)	14,133 (4.7)
Net area sown	118,746 (41.8)	133,199 (44.6)	140,784 (46.3)	141,572 (46.5)	143,008 (46.9)	139,015 (45.7)	140,299 (46.1)	142,003 (46.7)	141,769 (46.6)
Total cropped area	131,893 (46.4)	152,772 (51.2)	165,791 (54.6)	171,296 (56.3)	174,764 (57.4)	169,657 (55.8)	173,096 (56.9)	177,042 (58.2)	172,636 (56.8)
Area sown more than once	13,147 (4.6)	19,573 (6.6)	25,007 (8.2)	29,724 (9.8)	31,756 (10.4)	30,642 (10.1)	32,797 (10.8)	35,039 (11.5)	30,867 (10.1)
Cropping intensity	(111.1)	(114.7)	(117.8)	(121.0)	(122.2)	(122.0)	(123.4)	(124.7)	(121.8)
Total reporting area	284,315 (100.0)	298,458 (100.0)	303,758 (100.0)	304,332 (100.0)	304,680 (100.0)	304,128 (100.0)	304,167 (100.0)	304,280 (100.0)	304,110 (100.0)
Area for which no return exists	44,463 (13.5)	30,320 (9.2)	25,020 (7.6)	24,446 (7.4)	24,046 (7.3)	24,598 (7.5)	24,559 (7.5)	24,446 (7.4)	24,616 (7.5)
Total geographical area					..... 328.726				

Source : *Indian Agriculture in Brief*, 1986

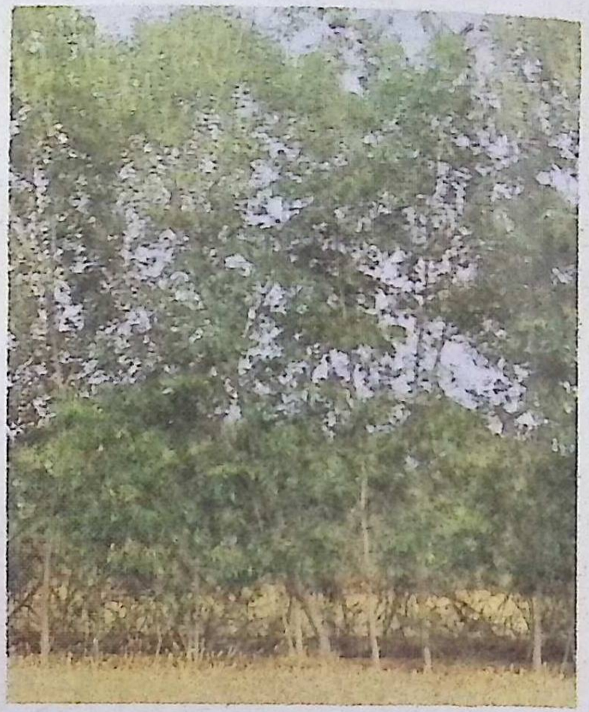
Deep ravines

Mangroves



Degraded hills

Mixed shelterbelt on drylands
Acacia auriculaeformis and *A. holosericea*



Waterlogged area with *Typha* sp

Social forestry—*Eucalyptus* planting on field-bunds soon, Tamil Nadu receives maximum rain during October–December with the onset of the North-East monsoon.

Flora and Fauna

India is floristically rich and varied, with *c* 45,000 species including the lower groups. The vascular flora comprises *c* 15,000 species, of which more than 60% are endemic and have so far not been reported anywhere in the world. Each climatic zone in India has characteristic species. In the name of development, great damage is caused to flora and fauna (65,000 species), as both are interdependent. Several species of plants and animals have already been included in the endangered list.

Population

The dynamics of the living population, plants and animals and their inter-relationship and interdependence in relation to their soil and environment and the natural resources are important. Any disturbance results in destruction and devastation. One of such most important disturbances is caused by the pressure of human population and livestock. The population in 1981 was *c* 685.2 million, an increase of *c* 25% over that of 1971. The projection for 1996–2001 is 986 million. This phenomenal increase is alarming, detrimental to the land and its resources, flora and fauna, as it causes serious disturbances. All the developmental activities will be brought to nought with the increase in population. To meet the increasing demands for food and fuel, the forests are cleared for agriculture, and the timber-trees in watershed areas also are felled; and industries, which release toxic substances to life, etc., are established. These are causing dangerous devastation leading to desertification of different types. The control of population is essential to repair the ghastly damages done to the land. In 1951, the *per-caput* availability of land was *c* 0.94 ha, which declined, as per the estimates, to 0.48 ha in 1986—almost half—and will further reduce to 0.33 ha by 2000 AD—almost one-third.

Land, Agriculture, Livestock and Poultry

These form the basic structure of the Indian economy. Since land is the major asset and confers social, economic and political importance, it has become a status-symbol. Ancestral properties have fragmented into uneconomic holdings; bunds have increased the wasted land. Distribution of governmental lands for houses, agriculture, etc. to satisfy the needs of the growing population has led to an alarming ecological imbalance.

Agriculture accounts for almost 57% of the Indian economy. The total cropped area in 1982–83 was *c* 172.6-million ha (Table 2), which is 89% of the operational holdings. The area reported under current fallow is 4.7%, whereas other fallow is 3.1%. Culturable wastelands account for 5.4% of the total area under the holdings. Other uncultivated land excluding fallow accounts for 10.5%. The detailed landuse classification from 1950 to 1983, statewise for 1982–83, changes during 1950–83 and projections up to 2025 AD are given in Tables 2,3 and 4. The area in the agricultural sector is increasing, thereby indicating the addition of land from other sectors, principally the forests (Table 2). Instead of adding new lands, the production per unit of land should be increased to prevent the destruction of forests and consequent disturbance in ecological balances and degradation (Table 5,6 & 11).

India is endowed with organic and inorganic resources. The members of *Poaceae* and *Fabaceae*, the two major food- and fodder-yielding families, are found in abundance besides several others. India has one of the largest accumulations of woody species (more than 5000), out of which over 2500 are trees; some of these yield fodder also. More than 150 species provide valuable timber. Several more have been introduced for food, fodder, fruit, timber, fuel, medicine, reclamation, etc.

The population of livestock in 1977 was *c* 369.5 million, of which 242.17 million were cattle and buffaloes, 116.5 million were sheep and goats, 7.7 million pigs, 1.0 million horses, ponies and mules, 2.05 million donkeys and camels and 160.9 million poultry. This animal population constitutes one-half of the buffaloes of the world, 17–20% cattle and one-sixth of world's sheep and goats. The population of livestock is expected to be *c* 473 million by 2000AD. The annual growth of animals is as alarming as that of humans. The uncontrollable numbers of herbivores, particularly those which are non productive, have caused and are causing great devastation, particularly in the hilly regions, leading to degradation of land and loss of topsoil. The number of herbivores in the forests rose by 54% during 1956–1972. The pastures and grazing-lands and the other public lands are the most disturbed and degraded because they have also been the most neglected areas. The result is scarcity of enough nutritive food.

DEGRADATION OF SOIL AND THE CAUSES

Over thousands of years, human activity has continuously disturbed not only life on land, but land itself. The disturbance, though gradual, definitely led to serious destruction and degradation in the course of time, particularly with the introduction of new and sophisticated tools. It has been estimated

TABLE 3—STATEWISE LANDUSE CLASSIFICATION, 1982-83*

(Provisional; million ha)

State/UTs	Reporting area	Forests	Area under non agricultural uses	Barren & unculturable land	Permanent pasture & other grazing-land	Land under misc. tree-crops and groves	Culturable wastelands	Fallow-lands other than current fallows	Current fallows	Net area sown	Total cropped area	Cropping intensity	Net irrigated area	Gross irrigated area
Andhra Pradesh	27,440	6,172	2,216	2,296	899	272	901	1,469	2,181	11,034	12,769	115.7	3,527	4,518
Assam	7,852	1,985	912	1,541	184	250	107	86	91	2,696	3,556	131.9	572	572
Bihar	17,330	2,736	1,659	964	136	214	415	937	1,991	8,278	9,641	116.5	2,319	3,350
Gujarat	18,826	1,965	1,078	2,502	845	4	1,969	302	491	9,670	10,189	105.4	2,155	2,522
Haryana	4,394	136	328	88	27	—	48	—	171	3,596	5,306	147.6	2,356	3,559
Himachal Pradesh	3,113	809	153	144	1,089	41	239	14	43	571	958	167.8	93	159
Jammu & Kashmir	4,506	2,759	304	256	123	94	145	8	93	724	1,002	138.4	318	405
Karnataka	19,050	3,030	1,131	829	1,260	332	495	491	1,126	10,356	11,151	107.7	1,486	1,792
Kerala	3,885	1,082	276	86	5	55	130	27	44	2,180	2,862	131.3	259	389
Madhya Pradesh	44,211	14,015	2,205	2,369	2,820	163	1,795	1,009	808	19,027	22,215	116.8	2,656	744
Maharashtra	30,758	5,312	998	1,722	1,584	183	987	804	866	18,302	19,957	109.0	1,927	2,686
Manipur	2,211	602	26	1,419	—	24	—	—	—	140	188	134.3	65	75
Meghalaya	2,249	812	85	231	17	145	454	261	51	193	208	107.8	50	51
Nagaland	1,099	286	28	—	—	200	63	262	95	165	178	107.9	66	76
Orissa	15,540	6,640	632	265	560	423	249	189	452	6,130	8,326	135.8	1,215	2,006
Punjab	5,033	216	440	90	4	4	37	1	39	4,202	6,915	164.6	3,550	6,148
Rajasthan	34,235	2,151	1,510	2,982	1,836	50	6,195	1,920	2,021	15,660	18,395	117.5	3,218	4,088
Sikkim	729	265	70	209	97	2	4	7	2	76	103	135.5	12	12
Tamil Nadu	13,001	2,030	1,781	590	155	201	330	568	2,087	5,259	6,030	114.7	2,255	2,732
Tripura	1,048	578	—	120	—	98	2	2	2	246	381	154.9	29	38
Uttar Pradesh	29,478	5,120	2,336	1,120	299	568	1,147	756	1,176	17,226	27,708	143.4	9,884	12,125
West Bengal	8,846	1,184	1,293	121	4	162	374	61	82	5,565	7,004	125.9	1,834	1,834
U Ts	9,006	7,276	111	28	12	69	230	329	221	473	594	125.6	123	148
All-India	340,110	67,161	19,582	20,139	11,956	3,554	16,313	9,503	14,133	141,769	172,636	121.8	39,969	52,029

*For detailed explanations, particularly for Assam and Jammu & Kashmir, see : *Indian Agriculture in Brief*, 1986.

TABLE 4—CHANGE IN LANDUSE IN INDIA FROM 1950–51 to 1982–83 AND PROJECTIONS FOR 2000 AND 2025 AD

(million ha)

Year	Reporting area	Forests	Non-agricul-turable uses	Barren & Un-culturable land	Culturable wasteland	Pastures and grazing-land	Misc. tree-crops and groves	Fallow-land	Net area sown
1950–51	284,315	40,482	9,357	38,160	22,943	6,675	19,828	28,124	118,746
1960–61	298,458	54,052	14,840	35,911	19,212	13,966	4,459	22,819	133,199
1970–71	303,758	63,917	16,479	28,161	17,500	13,262	4,298	19,357	140,784
1975–76	304,332	66,701	17,431	22,845	17,356	12,589	3,991	21,847	141,572
1978–79	304,680	67,468	19,083	20,263	17,309	12,134	3,578	21,837	143,008
1979–80	304,128	67,480	19,337	20,270	16,686	12,100	3,513	25,727	139,015
1980–81	304,167	67,421	19,477	20,166	16,699	12,007	3,489	24,609	140,299
1981–82	304,280	67,416	19,506	20,223	16,410	12,050	3,623	23,049	142,003
1982–83	304,110	67,161	19,582	20,139	16,313	11,956	3,554	23,636	141,769
*2000	318,000	70,000	26,000	30,000	9,000	15,000	5,000	13,000	150,000
*2025	318,000	70,000	36,000	24,000	4,000	15,000	6,000	8,000	155,000

Projections—*V P Agarwala*
* Source : *Indian Agriculture in Brief*, 1986.

TABLE 5—AREA UNDER FOREST IN DIFFERENT STATES

State/UTs	Total forest-area in sq km (% of geographical area of the State)	
	1972–75	1980–82
Andhra Pradesh	49,049 (17.72)	40,435 (14.61)
Assam	21,055 (26.81)	19,796 (25.21)
Bihar	22,687 (13.059)	20,139 (11.58)
Gujarat	9,459 (4.83)	5,057 (2.58)
Haryana	757 (1.71)	401 (0.91)
Himachal Pradesh	15,075 (27.08)	9,130 (15.40)
Jammu & Kashmir	22,335 (10.05)	14,361 (6.46)
Karnataka	29,480 (15.37)	25,656 (13.38)
Kerala	8,611 (22.15)	7,376 (18.98)
Madhya Pradesh	108,568 (24.52)	90,215 (20.37)
Maharashtra	40,682 (13.22)	30,350 (9.86)
Manipur	15,090 (67.49)	13,572 (60.70)
Meghalaya	14,390 (63.98)	12,458 (55.39)
Nagaland	8,154 (49.33)	8,095 (48.97)
Tripura	6,330 (60.40)	5,138 (49.03)
Orissa	48,383 (31.06)	39,425 (25.31)
Punjab & Chandigarh	1,120 (2.22)	499 (0.99)
Rajasthan	11,294 (3.30)	5,972 (1.75)
Tamil Nadu	16,676 (12.83)	13,187 (10.14)
Uttar Pradesh	25,869 (8.79)	21,002 (7.14)
West Bengal	8,347 (9.5)	6,483 (7.38)
Sikkim	1,761 (24.12)	2,883 (39.49)
Arunachal Pradesh	51,438 (61.54)	58,104 (62.34)
Dadra & Nagar Haveli	177 (36.12)	70 (25.51)
Delhi	18 (1.21)	10 (0.67)
Goa, Daman & Diu	1,221 (32.05)	1,139 (29.90)
Mizoram	13,860 (68.72)	11,971 (56.76)
*Total	551,886 (16.83%)	457,046 (13.94%)

*Excluding area of Andaman & Nicobar Islands for which reliable forest-cover data are not available due to cloud- and fog-cover.

Source : *T N Khoshoo.*

TABLE 6— CHANGE IN FOREST-COVER DURING 1972–75 AND 1980–82

Landuse	Area (million ha) 1972–75	1980–82	Change in forest-cover as per cent of total geographical area of the country
Forest-land			
Closed forest	46.10	35.43	(−) 3.25
Open/degraded forests	8.80	10.00	(+) 0.38
Mangroves	0.30	0.27	(−) 0.02
	55.20(16.83%)	45.70(13.94%)	2.89
New forest-land			
Agricultural land, Grass-land, Shrub-land, Non-forest plantations, & Barren land	255.70	267.40	(+) 3.58
Others			
Area under Snow, Fog, Cloud, Shadow, etc.	17.12	14.86	(−) 0.69
Total	328.00	328.00*	

*Excluding area of Andaman & Nicobar Islands for which reliable forest-cover data are not available due to fog and cloud cover.

Source : *T N Khoshoo.*

that each man needed about one square kilometre of land during the bow-and-arrow age. But, now with the world's population at 4.7billion and with the increasing degradation of land, the land available per head by 2000 AD is estimated at 0.33 ha only.

Wherever native vegetation and animal population are disturbed, the fertile top layers of the soil are also lost and irreparable damage is caused. These wasted lands cannot be reclaimed in one or two generations. Such soils can sustain life only if properly tended and the topsoil is reconstructed with nutrients and organic matter. Ironically, the human hand that caused destruction is needed for healing and establishing natural vegetation and animal population, and suitable new communities.

Man's quest for knowledge and comfort had also led to the discovery of several toxic chemicals, and nuclear power. These chemicals not only harm human life but destroy the biotic communities. Industrialization also causes pollution leaving deep scars on the land, and most of the plants and animals do not establish in such areas. The rivers also are polluted with industrial wastes and toxic effluents, and cease to support the growth of aquatic life. The enormous amount of energy released from nuclear power, if harnessed for the benefit of mankind, would considerably reduce the pressure on land for organic fuel. One of the major problems of nuclear-power generation is the disposal of nuclear waste. At present, nuclear wastes are being dumped into the oceans which destroy even the marine life leading to environmental hazard for generations of life yet to appear.

Disturbed Areas

The situation in India too is similar. Most of the human activities are leading to the destruction of forests in the plains and also on the mountains, the catchment areas and grazing-lands as in the Himalayas, or lush-green valleys of Assam, Arunachal Pradesh, Kerala, Maharashtra or Jammu & Kashmir. This destruction is leading to the formation of most hostile hot deserts as in Rajasthan or cold deserts as in Ladakh and Himachal Pradesh. Large areas in Gujarat, Rajasthan, Punjab, Haryana, Uttar Pradesh, and Madhya Pradesh have been eroded and drastically disturbed over the ages, resulting in the formation of The Thar Desert in Rajasthan, and gullies and ravines in Madhya Pradesh, Uttar Pradesh and Gujarat, and highly arid tracts in Punjab, Haryana and Uttar Pradesh. These disturbed areas can be classified into several categories (Table 7). The most apparent of these are overgrazed and eroded fields, urbanized lands, roads, railroads, industrialized sites, mines, etc. These have already destroyed large biotic communities. The annual loss of nutrients and production are also given in Table 7.

Erosion: Soil-erosion is always linked with economics. The topsoil, if lost, affects the productivity of soil, and such soils need additional inputs, such as irrigation and fertilizers, for consistent and high production. The slash-and-burn agriculture practised in various regions leaves the soil completely barren. Out of the world's total annual loss of soil amounting to *c* 25,658-million tonnes, India contributes 18.5%, which is maximum (Table 8). This is highly dangerous considering that the total landmass of India is only 2.4% in the world. The loss of topsoil reduces the organic matter, its fine tilth and aeration, and the soil-structure is adversely affected. The microclimate of the topsoil is so disturbed that the micro-organisms and other living beings are deprived of the organic matter, and the soil compacts. Such a situation, associated with reduced status of nutrients, results in the loss of the whole organic system. With the loss of 2–3-cm-thick topsoil, the yield of wheat and maize is reported to be reduced by 6%.

Causes: The degradation and destruction of soil are due to several unforeseen and not-so-unforeseen problems, such as rapid and unscientific spread of agriculture, construction of hydro-electric projects, dams, canals,

TABLE 7—PROBLEMS OF SOIL-EROSION AND LAND-DEGRADATION

1.	Geographical area		329 m ha
2.	Area subject to water- and wind-erosion		150 m ha(includes 2.1 & 2.2)
2.1	Area subject to wind-erosion and aridity	38.74 m ha	
2.2	Area affected by sand-dunes out of 38.74 m ha	7.00 m ha	
3.	Area degraded through special problems		25.06 m ha
3.1	Waterlogged area	6.00 m ha	
3.2	Alkali soils	2.50 m ha	
3.3	Saline soil including coastal-sandy areas	5.50 m ha	
3.4	Ravines and gullies	3.97 m ha	
3.5	Area subject to shifting-cultivation	4.36 m ha	
3.6	Riverine and torrents	2.73 m ha	
		25.06 m ha	
4.	Total problem-area (2 + 3)		175.06 m ha
4.1	Annual average loss of nutrients from land		5.37 to 8.4 m tonnes
5.	Average annual loss of production for not developing ravines estimated at		3.0 m tonnes
6.	Average annual rate of encroachment of table-lands by ravines		0.008 m ha
7.	Average area annually subject to damages through shifting cultivation		1 m ha
8.	Total flood-prone area		40 m ha
8.1	Annual average area affected by floods		9 m ha
8.2	Annual average cropped area affected by floods		3.8 m ha
9.	Total drought-prone area		260 m ha
10.	Additional land needed by 2000 AD		60 m ha
10.1	For crop-production	10 m ha	
10.2	For production of fuelwood	40 m ha	
10.3	For production of fodder	10 m ha	

Source : *Indian Agriculture in Brief*, 1986.

reservoirs, roads and railroads, urbanization, industrialization, shifting- and terrace-cultivation on hillsides, pressure from the rising human and livestock population, indiscriminate felling of trees and faulty management of land and water. Deforestation, overgrazing, overcultivation, industrialization, and unscientific cultural practices denude the land of its protective green cover, hastening the process of soil-erosion, degradation, waterlog-

TABLE 8—ESTIMATED EXCESSIVE EROSION OF TOPSOIL FROM WORLD CROPLAND

Country	Total Cropland (million ha)	Excessive soil-loss (million tonnes)
India	141.2	4,747.8
China	100.0	4,343.7
Soviet Union	253.1	2,525.4
United States	171.8	1,717.3
Total	666.1	13,334.1
Rest of World	614.7	12,324.0
Grand Total	1,280.8	25,658.1

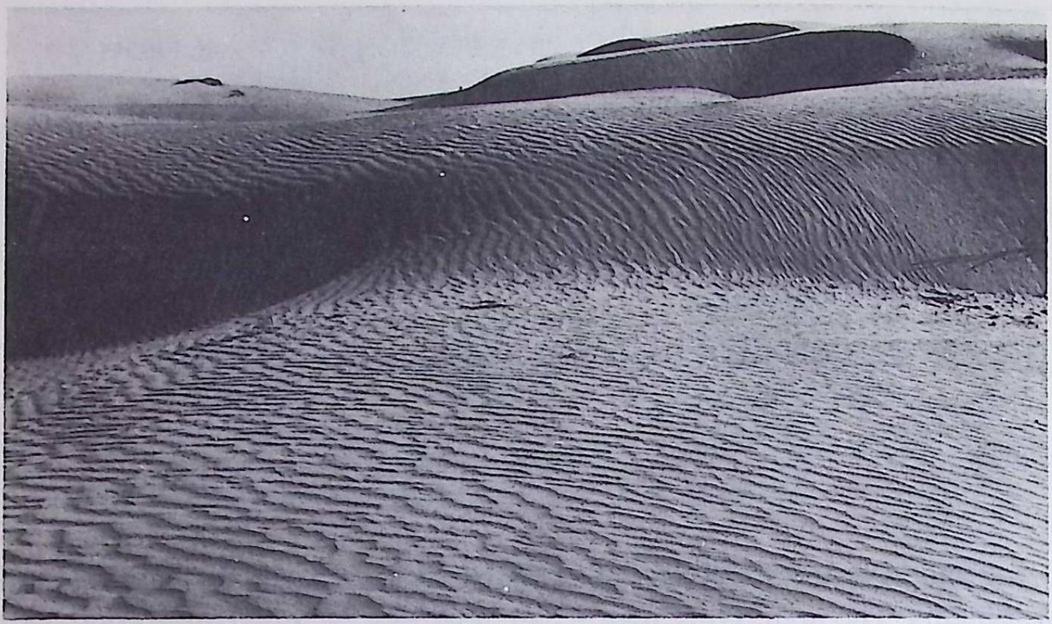
Source : *T N Khoshoo.*

ging and salinity. Both cultivated and uncultivated lands suffer from these problems. The underlying reason can, however, be much more complex.

Mining is yet another cause which disturbs the land,though it is also a priority sector next to agriculture. The total area under mining is estimated at *c* 683,672 ha. Mining is likely to increase from 43% in 1982–83 to 61% at the beginning of 21st century. In India, mining was never organized to combat soil-degradation, and environmental pollution. The visual impact of deforestation during mining is dramatic.

Open mines leave ugly scars and cause great damage to the rich topsoil and the watersources. In India, Kudremukh and Neyveli are the best examples, particularly the former where lush-green forests existed not long ago. Now, these have virtually disappeared; also the fines from washings are polluting the water-courses around making them unfit for any purpose. Silting is a common phenomenon. These scars are very difficult to erase. During the 1970's, limestone quarries in the Mussoorie catchment area in Uttar Pradesh increased threefold and roads were mercilessly cut through the forests, trees hacked down for the heavy machinery, and the land was shattered by blasting with dynamite and these areas are now totally denuded. If such areas are not reclaimed, they adversely affect the surroundings, causing landslides and caving-in and further erosion through water, resulting in silting of downstreams.

The impact of extensive disturbance through mining extends far beyond the immediate forest. In Almora district of Uttar Pradesh, the dust from the processed magnesite has settled on the fields of neighbouring villages, making them infertile. In Madhya Pradesh, the Bailladila iron-ore mines have polluted the Sakhini river making the water unfit for consumption.



Barren sand-dunes

Till about the last decade there was very little effort to afforest the degraded lands, which continued to be exploited excessively and indiscriminately. This pattern of exploitation 'for development' has continued for more than a century in India and has led to disaster. The Neyveli Lignite Corporation has, however, been reported to take excellent care of the environment and reclamation.

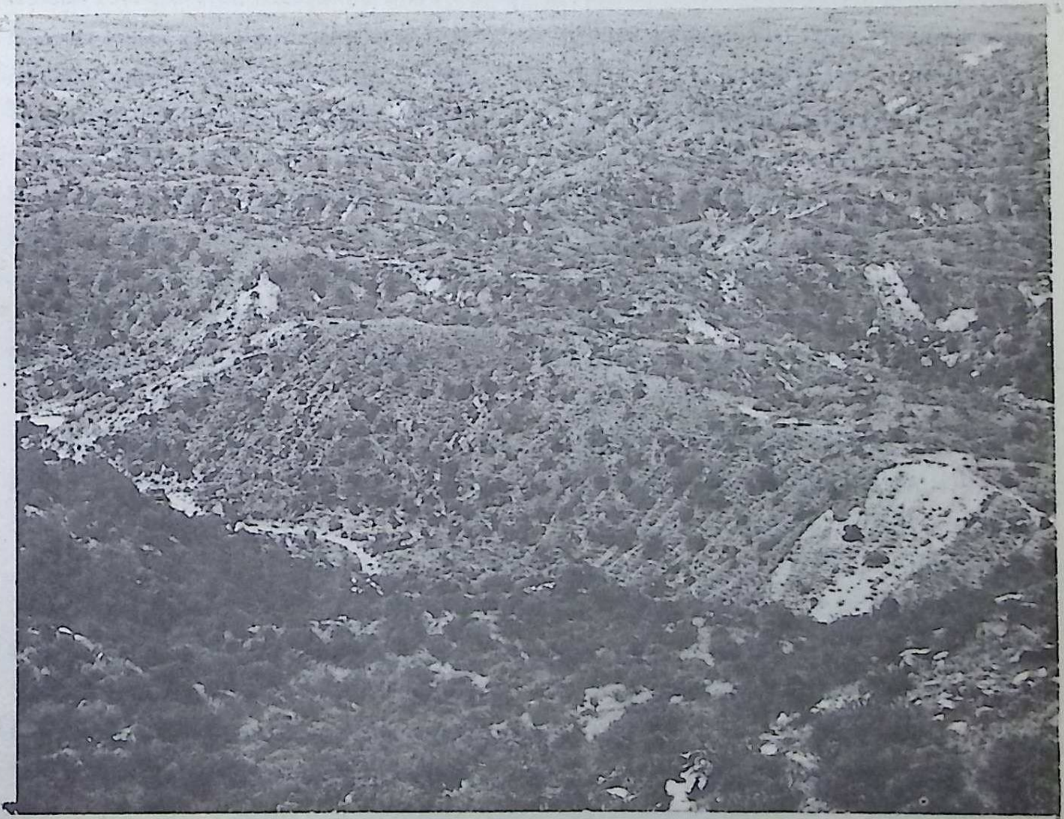
The loss is not only in the form of topsoil and lower layers of soil but in the form of colossal expenditure involved in repairing such areas, which otherwise could have been saved and better spent on other activities had the mining been carefully organized. And a large part of the land in the country is not yielding the expected or desired rate of productivity due to these causes.

All these degradations discussed above are due to lack of ground-cover. Other forms of degradation are salinity and alkalinity due to over-exploitation and modern irrigation-systems with improper or without drainage. These degradations are common beyond the geographical and political barriers. For example, some problems, say in Asia, from the West Asian deserts to Uttar Pradesh are common and require concrete, combined efforts with neighbouring countries and international organizations to halt the dangerous destruction.

The land should, as far as possible, be restored to its original biotic conditions to enable the native plants and animals to fill the same ecological niche and build up the topsoil. Hence, the lands should be reclaimed and rehabilitated. However, the urgency may alter the method of rehabilitation as quick results are needed with quick-growing plants suitable to those areas.

IMPORTANCE OF TOPSOIL

The layer of topsoil, covering the Earth's surface, has been formed by the breaking down of rocks over millions of years. Gradual accumulation of organic matter has stabilized the soil, controlling wind- and water-erosion naturally. It was estimated that a thousand years are needed to produce 2.5-cm-thick mature soil. The topsoil is *c* 20-cm thick and is the most important layer for cultivation. The organic matter in the topsoil helps plants grow besides sheltering a variety of other foms of life. In turn, they provide the supporting system for higher forms of life thus developing into a complex, interdependent biotic cycle or ecosystem. These soils are moisture-laden and are 'living' with millions of organisms of various groups of plants and animals which interact among themselves. These organisms along with the organic matter keep the soil dynamic. The plants



Obstacle sand-dunes with scanty vegetation in the background

and animals renew nutrients and improve the topsoil, each helping the other in this complex cycle of ecosystem, and prevent compaction. Some of the microorganisms fix nitrogen directly and some in association with the roots of leguminous plants, enriching the soil.

Rain and wind, besides human and animal depredation, change the landscape and cause erosion. Where there is a cover of thick vegetation of grasses and trees, the rate of removal of soil is very slow and low, as these break the force of rainwater and act as windbreaks. Once the green cover is removed, the nutrient-giving and life-harbouring topsoil is washed away or blown off causing erosion in a period of one or two years. Destruction of such important cover leads not only to the removal of topsoil but to form gullies, ravines, deserts, etc. Continuous unscientific cultivation without any conservation measures also leads to destruction and devastation. Natural erosion is slow but erosion by interference is markedly devastating. If one cubic metre of soil is lost per week over a period of 30 years or one generation, the loss is reported to amount to 38 cm from the entire crust of Earth. If this topsoil is not protected, even subsistence farming will be difficult and will lead to famine.

It is reported that in the USA, in spite of the excellent soil-conservation services and with relatively high soil-cover, nearly 2-million tonnes of soil are lost in 24 hours through rivers into the Atlantic and Pacific Oceans. In India, with perpetual destruction of soil-cover resulting in very high rate of floods, and also without minimum soil-conservation facilities, the quantity of topsoil lost is almost incalculable. Such devastation has converted millions of hectares into wastelands and several more into submarginal lands. Sheet-erosion is a very commonly observed phenomenon in the Indo-Gangetic alluvium, black soils of Madhya Pradesh, Andhra Pradesh, Maharashtra and Karnataka, and the red soils found in South India and eastern India.

The recent surge of awareness about the environment and the drastic ecological disturbances occurring in the name of development have alerted the Government to give top priority for reconstructing and healing the damage caused by man, and imposing stringent laws.

Nature, like a living cell, has enormous inherent potential to heal the wounds caused to the land but a certain critical limit exists beyond which even healing is not possible unless external treatment and caressing are given at the correct time. Some damages, however, become irreparable. To understand the critical period, it is necessary to understand the waste- or wasted lands and collect approximate estimates for proper planning and priorities to heal these damaged lands.

WASTELANDS

DEFINITION(S)

Common Understanding—Land which does not give enough economic return or is otherwise useless can broadly be termed as wasteland. The wasteland normally is uncultivated, uninhabited and bare land lacking moisture, with a stress of climate and poor quality of soil, which is not conducive to regeneration of vegetation. Depleted of the green cover, and the ability to withhold water and soil, these lands are in a critical condition. Partially degraded lands can be called 'wasted lands' rather than wastelands. Though widely accepted, such definitions are not probably exact or correct, since the economic viability also depends upon the methods of exploitation, the inputs and scientific technologies utilized.

One of the recent classifications mentions that wastelands are those which are: (*a*) ecologically unstable,(*b*) whose topsoil has nearly or completely been lost, and (*c*) which develop toxicity in the zone of roots for the growth of most plants. The definition will cover all those lands which are affected by water-erosion, wind-erosion, floods, waterlogging and salinization and alkalinization. According to another classification, degraded forests, riverain areas, gullies and ravines, shifting-cultivation and sand-dunes are also included. The problems concerning most of the soils are: sheet-erosion, waterlogging, shifting-cultivation, salinity and alkalinity, shifting sand, wind-erosion, extreme moisture-stress and coastal sand-dunes.

Analyzing these problems, regrouping of these wastelands may be attempted as: (a) *Water-erosion:* Includes sheet-erosion, ravines, riverain lands, waterlogging, gully-erosion, and shifting-cultivation; (b) *Wind-erosion:* Includes shifting sand-dunes, extreme moisture-stress, coastal sand-dunes, etc., and (c) *Salinity and Alkalinity*.

The wastelands can, however, also be grouped into the following three broad categories: (*1*) Cultivated land affected by soil-erosion; (2) Degraded forest-land; and (*3*) Degraded land with special problems or problem soils, such as acidic soils, saline and alkaline or sodic soils, peat, coastal saline soils, waterlogged lands, coastal wetlands (mangroves), saline blanks, arid and semi-arid lands, sand-dunes and shifting sand-dunes, cold deserts, gullies and ravines, riveraine torrent and sediment lands, grasslands and rangelands, shifting-cultivation lands and mined wastelands.

Definition by NWDB

Since various types of classification of wastelands and difinitions are suggested, the Union Government has constituted a two-tier structure to evolve a dynamic landuse policy. The apex-body, the National Land Use and Wastelands Development Council, oversees the National Land Use and Conservation Board in the Ministry of Agriculture, and National Wastelands Development Board (NWDB) in the Ministry of Environment and Forests. These two boards have been instituted to prepare programmes and implement them.

The NWDB has identified that comprehensive definitions and estimation of the status of wastelands in the country are very important. Standardized definition can be utilized for understanding the data generated by various agencies on the wastelands for obtaining as near real estimates as possible. But, different organizations have classified the wastelands in different ways, and, therefore, the data generated on the estimation differ widely. Hence, it is felt that standardization is essential.

Accordingly, a Technical Task Group* was constituted by the Planning Commission and NWDB, and this group defined the wastelands as follows: *'Wastelands' is defined as that land which is degraded and is presently lying unutilized except as current fallows due to different constraints*. These wastelands have been classified by NWDB as follows: Culturable Wastelands and Unculturable Wastelands.

I *Culturable Wastelands*

Land which is capable of or has the potential for the development of vegetative cover and is not being used due to different constraints of varying degrees is termed as culturable wasteland.

The culturable wastelands comprise the following categories:

Gullied and/or Ravinous Land

(a) *Gullied Land*—The gullies are formed as a result of localized surface runoff affecting the friable unconsolidated material resulting in the formation of perceptible channels resulting in undulating terrain. The gullies are the first stage of excessive land dissection followed by their networking which leads to the development of ravinous land.

(b) *Ravinous Land*—The word 'ravine' is usually associated not with an isolated gully but a network of gullies formed generally in deep alluvium and entering a nearby river, flowing much lower than the surrounding tablelands. The ravines then are extensive systems of gullies developed along river-courses.

Undulating Upland with or without Scrub

This is the land which is generally prone to degradation and may not have scrub-cover. Such land occupies topographically high locations in the respective systems. This excludes hilly and mountainous terrain.

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*The Technical Task Group Report may be consulted for details.

*Surface-waterlogged Lands and Marsh**

(a) *Surface-waterlogged Land*—Surface-waterlogged land is that where the water is at/or near the surface and water stands for most of the year.

(b) *Marsh*—Marsh is a land which is permanently or periodically inundated by water and is characterized by vegetation which includes grasses and reeds.

Salt-affected Land

The salt-affected land is generally characterized as the land that has adverse effects on the growth of most of the plants due to the presence of excess soluble or excess exchangeable sodium.

The alkali (-ne) land has an exchangeable sodium percentage (ESP) of about 15 which is generally considered the limit between normal and alkali (-ne) soils. The predominant salts are carbonates and bicarbonates of sodium.

Shifting-cultivation Area

Such land is the result of cyclical landuse, consisting of felling of trees and burning of forest-areas for growing crops. This results in extensive soil-losses leading to land-degradation.

Degraded Forest-lands

Land as notified under the Forest Act and those lands with various types of forest-cover, in which denudation of vegetative cover is less than 20% of canopy-cover, are classified as degraded forest-land.

Degraded Pastures/Grazing-lands

All those grazing-lands in non forest-area whether or not they are permanent pastures or meadows, which have become degraded due to lack of proper soil-conservation and drainage measures, fall into this category.

Degraded non Forest-plantation Land

Degraded lands containing plantations outside the notified forest-area.

Strip-land

These are long, narrow strips of land on either side of transportation

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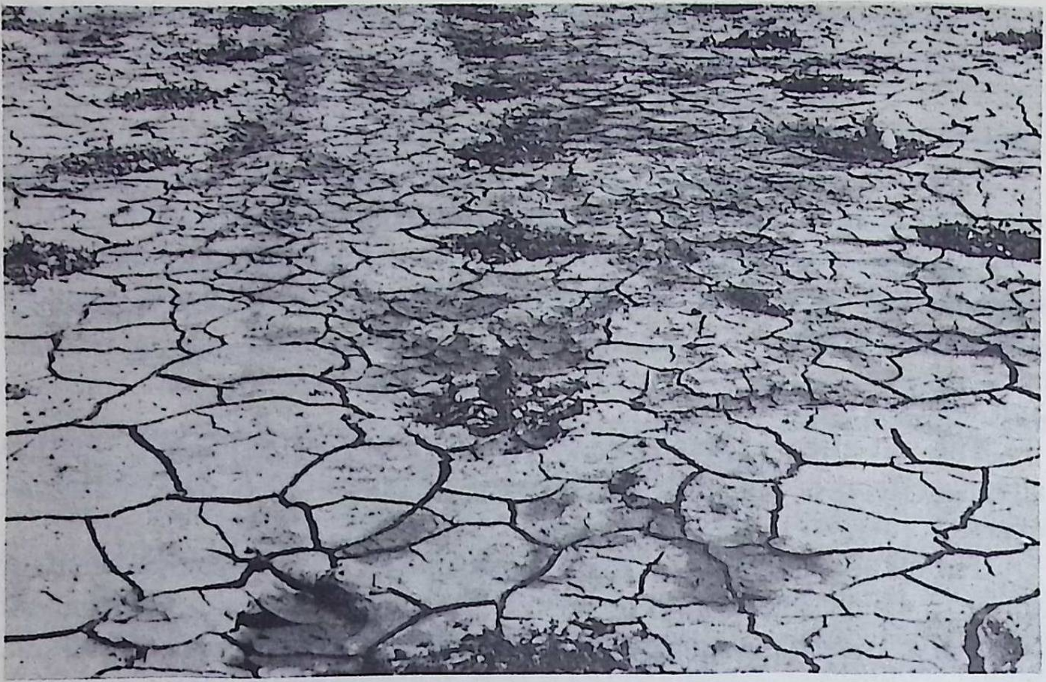
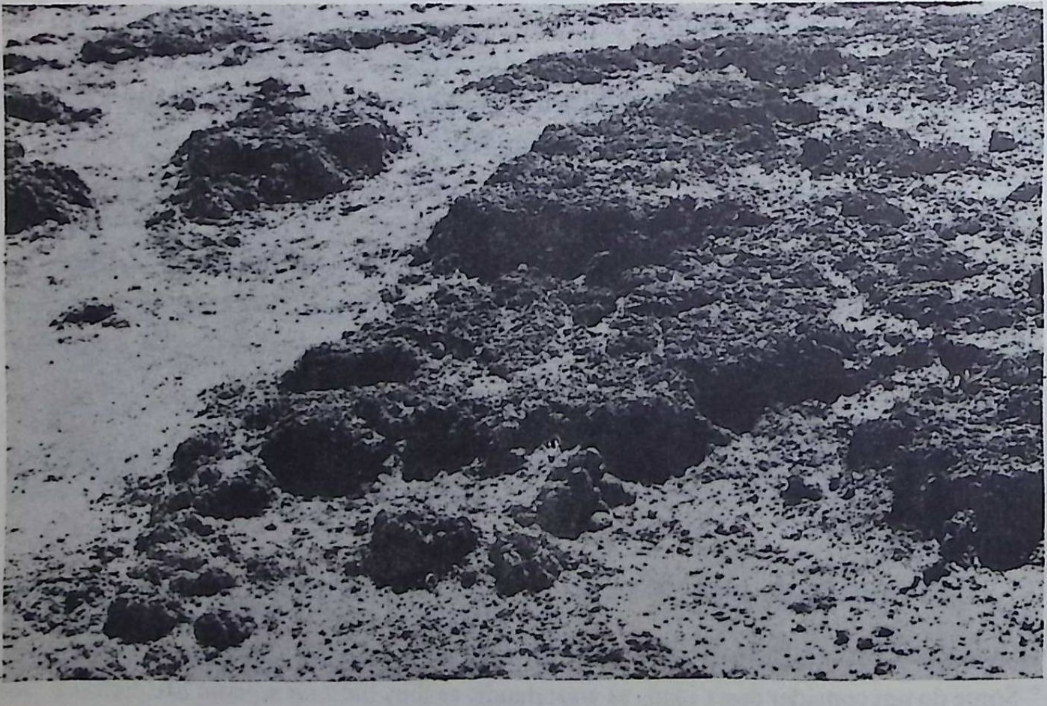
* Some do not consider these lands as wastelands, as they harbour aquatic life yielding food and fodder and become sanctuaries to wildlife and birds.



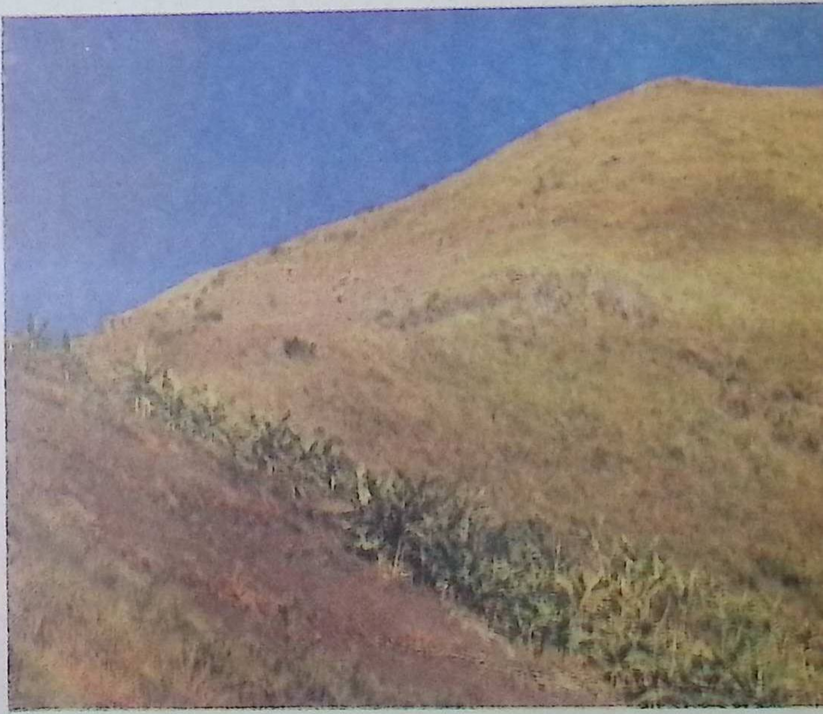
Cracked soil-surface—Characteristic of alkaline land,
Planted with *Pithecellobium dulce*



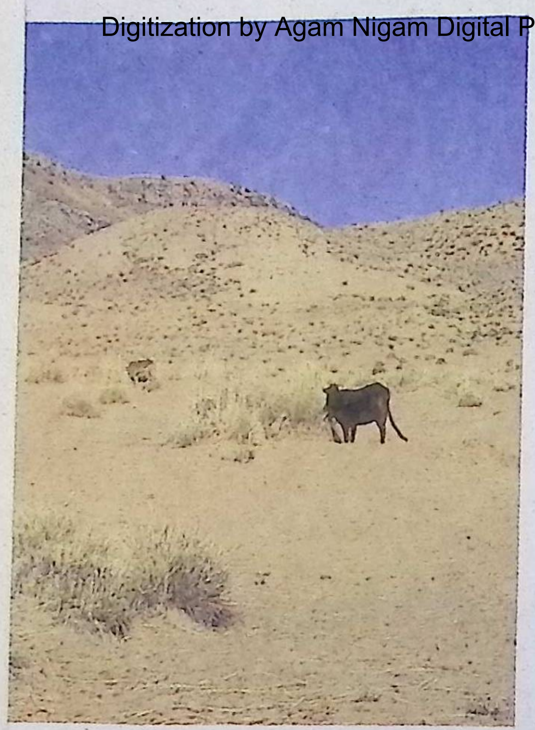
Hard and granular soil-surface with hard pan exposed due to erosion

Salt-affected land

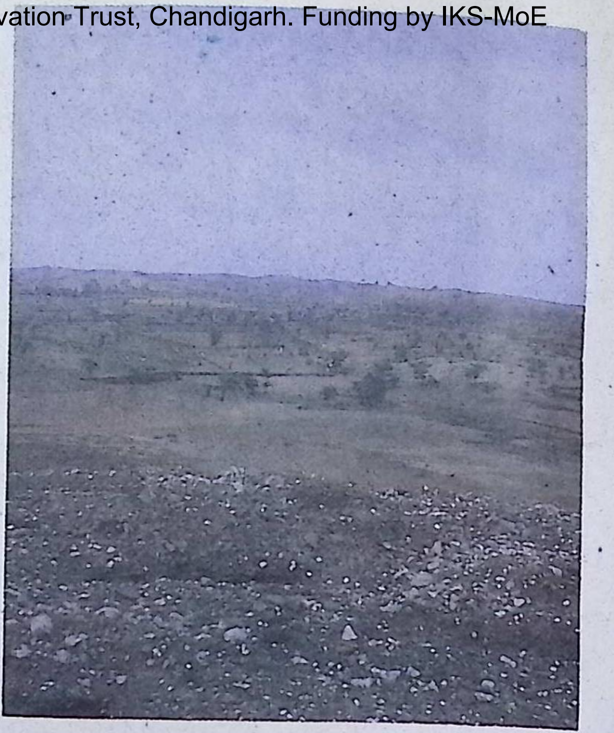
Destruction of forests on the hills for crops



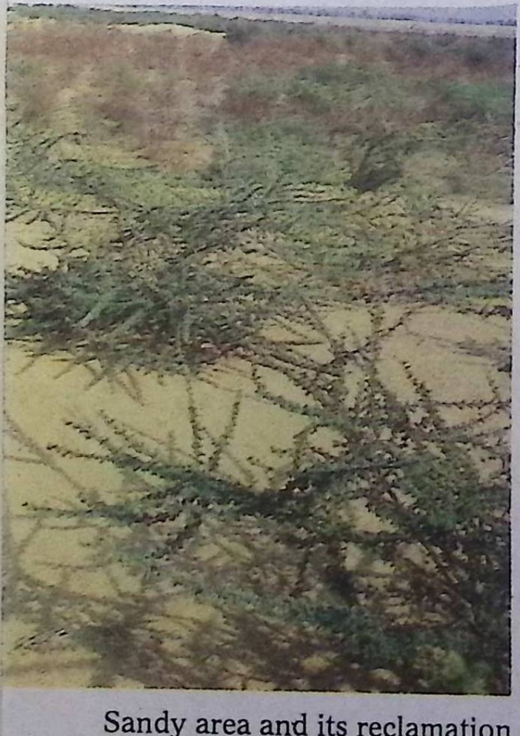
Destruction of catchment area



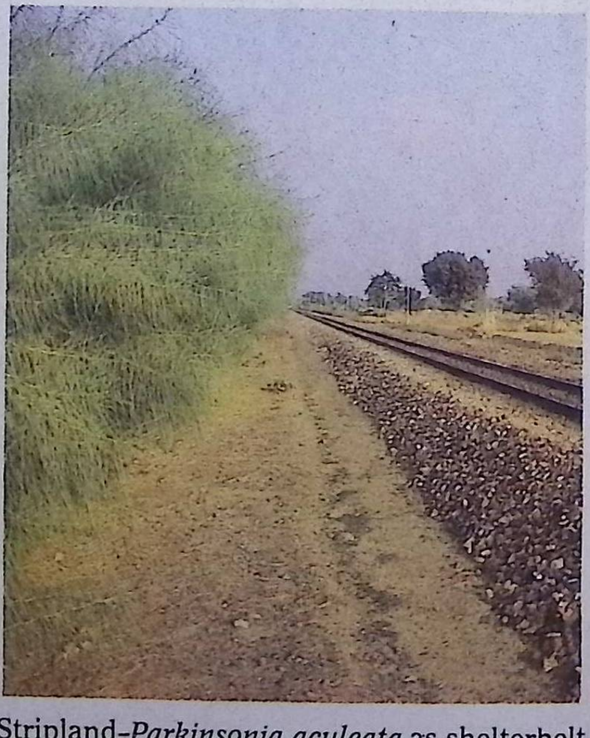
Degraded grazing-lands



Rocky degraded plains



Sandy area and its reclamation



Stripland-*Parkinsonia aculeata* as shelterbelt (rail-and-road) networks and canalbunds, which are hospitable for the growth of vegetative cover.

Sands

Sandy areas are those which have stabilized accumulation of sand *in situ* or transported, in coastal, riverain or inland areas.

Mining/Industrial Wastelands

(a) *Mining Wastelands*—Lands where large-scale mining operations bring about the degradation of land and resultant mine-dumps.

(b) *Industrial Wastelands*—Lands which are subject to degradation caused by large-scale industrial effluent discharges.

II *Unculturable Wastelands*

Lands, which cannot be developed for vegetative cover, are defined as unculturable wastelands. Unculturable wastelands are divided into :

Barren Rocky/Stony Wastes/Sheet-rock Area

Self-explanatory.

Steep-sloping Area

Land with very steep slopes (greater than 35°) prone to erosion and mass-wasting (landslides).

Snow-covered and/or Glacial Area

Self-explanatory.

ESTIMATES

The first comprehensive review on the wastelands or wasted lands was undertaken by National Commission on Agriculture in 1976 which estimated different types of wastelands, and suggested necessary guidelines for reclaiming and developing such degraded lands. The official estimates of wastelands is *c*175-million ha which is more than half of the national geographic area (Table 7). The National Commission on Agriculture also estimated that the forests the country lost between 1951 and 1972 amounts to 3,402,000 ha (Table 9). Unofficial estimates place the annual rate at over one-million ha. This trend has to be reversed, as otherwise it will lead to the total loss of forests by the beginning of the 21st Century. Recent reports indicate that an area of *c* 29-million ha was treated by 1984-85, and the remaining wasteland is estimated to be *c* 144-million ha. Detailed Statewise data of total land lost due to soil-erosion and degraded lands, the area treated and the area to be treated are given in Table 10. Accordingly, Rajasthan

TABLE 9—FOREST-AREA LOST BETWEEN 1951 AND 1972 ON VARIOUS PROJECTS*

Purpose	Area (ha)
River-valley projects	401,000
Agricultural purposes	2,433,000
Roads and Communications	55,000
Establishments of industries	125,000
Miscellaneous	388,000
Total Area lost	3,402,000

*According to National Remote Sensing Agency, during 1972–75 the forest-cover was 55,520,000 ha and 1980–82 was 46,350,000 ha; the estimated loss was 9,170,000 ha.

Source : *Sumi Krishna.*

possesses maximum wasteland,followed by Madhya Pradesh, Andhra Pradesh, Uttar Pradesh, Gujarat, Maharashtra and Karnataka; probably Jammu & Kashmir also possesses large stretches of wastelands. The unofficial estimates of wastelands, excluding non forest-area, according to landuse categories and problem-areas by Bhumbla and Khare suggest that official estimates were probably on the higher side.

The National Remote Sensing Agency in 1983 reported that the area under forests (excluding 14.8-million ha covered by snow, cloud, etc.) was 46.3-million ha which showed a decrease of *c* 9-million ha (16.52% over the figures for 1972-75) (Table 11). The aerial mapping of country shows only *c* 55.41-million-ha wastelands (Table 12). According to these estimates and statewise breakup, Rajasthan has the maximum wasteland (45.3%), followed by the hillstates. But, these data also appear to be not very accurate and are open to correction.

The estimated wastelands, as per the report of the Ministry of Agriculture, are *c* 175-million ha. The Directorate of Economics and Statistics of the Ministry of Agriculture provides the following classification of landuse for 1982-83 (Table 2) : (*i*) Forest (22.1%), (*ii*) Area under non-agricultural uses (6.4%), (*iii*) Barren and unculturable land (6.6%), (*iv*) Permanent pastures and other grazing-lands (3.9%), (*v*) Land under miscellaneous tree-crops and groves (1.2%), (*vi*) Culturable wasteland (5.4%), (*vii*) Fallow-lands other than current-fallows (3.1%), (*viii*) Current fallow (4.7%), and (*ix*) Net-sown area (46.6%). From these categories, the wastelands have to be estimated.

TABLE 10—STATEWISE TOTAL PROBLEM-AREAS, AREAS TREATED AND BALANCE YET TO BE TREATED

(million ha)

State/UTs	Total problem-area			Area treated till 1984–85	Balance yet to be treated
	Due to soil erosion	Land-degradation	Total		
Andhra Pradesh	11.502	0.729	12.231	0.772	11.459
Assam	2.217	0.782	2.999	0.158	2.841
Bihar	4.260	2.292	6.552	0.902	5.650
Gujarat	9.946	2.640	12.286	2.283	10.303
Haryana	1.591	2.571	4.162	0.346	3,726
Himachal Pradesh	1.914	—	1.914	0.240	1.674
Jammu & Kashmir	0.883	0.010	0.893	0.187	0.706
Karnataka	10.989	0.414	11.403	3.108	8.295
Kerala	1.757	0.178	1.935	0.195	1.740
Madhya Pradesh	19.610	1.107	20.717	3.825	16.892
Maharashtra	19.181	0.665	19.846	9.550	10.296
Manipur	0.374	0.360	0.734	0.088	0.646
Meghalaya	0.837	0.265	1.102	0.091	1.011
Nagaland	0.405	0.770	0.482	0.081	0.401
Orissa	4.578	3.228	7.803	0.619	7.184
Punjab	1.007	2.223	3.230	0.583	2.647
Rajasthan	19.902	17.492	37.394	0.155	35.841
Sikkim	0.303	—	0.303	0.069	0.234
Tamil Nadu	3.640	0.182	3.822	1.081	2.741
Tripura	0.167	0.112	0.279	0.092	0.187
Uttar Pradesh	7.110	6.005	13.115	2.778	10.337
West Bengal	1.033	3.270	4.303	0.310	3.993
UTs	3.414	0.400	3.814	—Not available—	
Total	126.620	44.999	171.619	29.383	142.236
		1.465*	1.465*		
Grand Total	126.620	46.464	173.084	29.383	143.701

*Coastal sand not reported Statewise.

Source : *Indian Agriculture in Brief*, 1986.

TABLE 11—VITAL FOREST STATISTICS

	1972–75	1980–82
Forest-cover (million hectare)	55.52	46.35
Closed forest (million hectare)	46.42	36.02
Open forest (million hectare)	8.77	10.06
Mangrove forests (million hectare)	0.33	0.26
Forest-cover (% of total land area)	16.89	14.10

Source : *National Remote Sensing Agency.*

TABLE 12—WASTELANDS—AERIAL ESTIMATION (Sq km)*

State/UTs	Salt-affected land	Gullied or ravinous land	Undulating upland with or without scrub	*Jhum* or forest-blank	Sandy areas	Barren hill-ridge or rock outcrop	Snow-covered or glacial area	Total	Percentage
Rajasthan	497,640	8,766,120	7,656,009	—	130,193,938	7,770,840	—	154,884,547	45.258
Jammu & Kashmir	38,280	—	76,560	2,373,360	—	153,120	70,054,141	72,695,461	32.710
Tripura*†	—	—	382,800	2,641,320	—	—	229,680	3,253,800	31,056
Himachal Pradesh	—	—	459,360	995,280	—	—	13,589,800	15,044,440	27.022
Manipur	—	—	306,240	5,014,680	—	344,520	—	5,665,840	25.340
Sikkim	—	—	765,600	—	—	—	1,077,840	1,843,440	25.256
Mizoram†	—	—	—	3,981,120	—	—	497,640	4,478,760	21.238
Meghalaya	—	—	—	4,555,320	—	191,400	—	4,746,720	21.106
Nagaland	—	—	—	3,253,800	—	—	—	3,253,800	19.686
Gujarat	13,206,600	7,962,240	8,995,800	—	842,160	612,480	—	31,619,279	16.132
Arunachal Pradesh	—	—	191,400	5,512,320	—		7,732,560	13,436,280	16.076
Uttar Pradesh	19,407,961	8,842,680	880,440	2,794,440	913,720	880,440	7,043,520	40,786,199	13,846
Kerala†	—	—	803,880	3,483,480	—	918,720	114,840	5,320,920	13.690
Tamil Nadu	574,200	4,210,820	6,507,600	3,330,360	1,914,000	1,071,840	—	17,610,801	13.538
Orissa	153,120	—	13,326,160	662,240	382,800	—	—	19,484,506	12.506
Karnataka	267,960	2,220,240	12,517,560	3,100,680	—	3,828,000	—	21,934,439	11,436
Andhra Pradesh	880,440	4,517,040	18,642,359	880,440	1,033,560	4,708,440	—	30,662,279	11.076
Madhya Pradesh	—	21,283,680	13,436,280	7,005,240	—	2,411,840	—	19,484,506	9.966
Maharashtra	1,186,680	7,388,040	19,637,641	1,454,640	—	995,280	—	30,662,279	9.962
Goa, Daman & Diu	—	—	306,240	38,280	—	—	—	344,520	9.034
Haryana	1,110,120	191,440	—	76,560	1,492,920	842,160	—	3,713,160	8.396
Bihar	—	1,875,720	8,727,840	2,373,360	—	2,335,080	—	15,312,000	8.806
Punjab (including Chandigarh)	1,301,520	—	—	—	2,603,040	—	—	19,484,506	7.730
West Bengal	1,263,240	—	4,249,080	535,920	—	306,240	—	6,354,480	7.232
Assam	—	—	5,742,000	2,373,360	—	—	—	2,947,560	3.752
Grand Total	39,887,760	67,257,960	117,443,040	62,396,400	139,381,140	27,025,680	100,684,540	554,076,520	

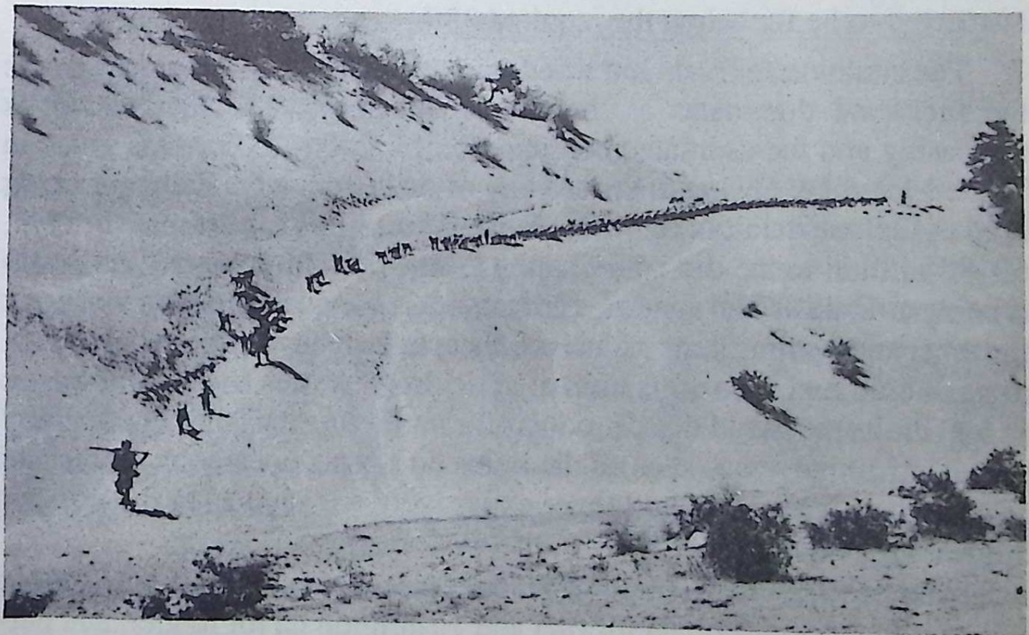
*Estimates are likely to err on the lower side.

†Interpretation of data on Tripura, Mizoram and Kerala appear to be erroneous.

Source : *National Remote Sensing Agency.*

STATUS OF FOREST-LANDS

Most of the forest-soils are poor in quality nutrient. When the land is cleared of trees and exposed to the sun, some forest-soils, especially those containing iron and aluminium, dry out and become hard, called laterite, which are virtually incapable of supporting vegetation. When the forest-floor is exposed to the sun, the normally-dense and nutrient-rich litter, consisting of fallen leaves and animal and human products, begins to decompose faster than it forms, losing volatile elements. Even a moderate flow of rainwater can erode such exposed soil. The erosion of topsoil is particularly damaging because this layer contains maximum amount of decomposing organic matter. Degraded forest-lands degenerate into scrub-lands where only aggressive shrubs and weeds grow. Such land is between 20- and 40-million ha. If the organic matter is retained, it improves the physical texture of the soil by binding soil-particles; it also improves drainage, encourages and permits root-growth and reduces the force of rain-drops, thereby reducing erosion and increasing the water-retention capacity and permits percolation. This improves watertable. Although it is difficult to quantify, the depletion of organic matter can have a variety of negative effects on the soil. India has a forest-cover of 1.85% of the world's forests (4057million ha), but has to support 15.64% population and 14% livestock



Sand-dunes with interference by sheep and goats of the world. The National Forest Policy (1952) recommended 33% of the total area under forest-cover, with 60% on the hills. The Government of India had proposed amendment to this policy in 1988. The total area under forests in India, according to the estimates of the Ministry of Agriculture during 1982–83, was, however, reported to be *c* 67.16-million ha which is *c* 22.1% (Table 2), whereas, in reality, it is suspected to be not more than 11.14%. And, this area also is under tremendous pressure. The satellite photographs of the Indian landmass have revealed that the country is losing its forest-cover at an alarming rate of *c* 1.5-million ha per year. The total area of forests in India may actually be as low as 40-million ha. The continuous pressure on the forests has resulted in over-exploitation, leading to disaster, particularly in the highly sensitive areas, such as the Himalayas, Rajasthan, Gujarat and Western Ghats. It is reported that only Assam, Himachal Pradesh, Meghalaya, Orissa, Andaman & Nicobar Islands, Arunachal Pradesh, Tripura and Madhya Pradesh are above the prescribed limit of 33%; Kerala, Goa, Daman and Diu, Manipur, Maharashtra and Andhra Pradesh perilously maintain 20% plus. The rest of the States have less than 20%. The estimated land that was lost for various 'developmental projects' during 1951–72 is mentioned in Table 9.

The demand for land for various activities is increasing. The agricultural and forest-lands cannot be utilized for industrialization and urbanization. Rather, the land for improving agriculture and forest is needed, particularly for the latter activity as the estimated real forest-cover is suspected to be far below the required 33%.

The situation for fuel- and wood-based industries is very precarious as the fuelwood dominates as the source of energy. The requirement is increasing and the estimated consumption for 2000–2005 AD is given in Table 13 and 14. Owing to the scarcity of fuelwood, animal dung is being used as fuel, especially in northern India. According to an estimate in 1973, 60–80-million-tonne dry animal dung (300–400-million-tonne wet dung) is being utilized as fuel annually. In fact, it is reported that buying inorganic fertilizer and burning dung as fuel are cheaper than buying the conventional or gas-based fuel. The utilization of agricultural wastes and animal wastes as fuel limits the use of these products for improving the lands, particularly in erosion-prone areas, such as the fields on steep slopes or on deforested lands. These wastes are no longer extensively recycled as in the past for improving the lands.

It has been estimated that, with the expected increase in the population, an additional 40-million ha for fuel and 10-million ha for fodder, and net-sown area of 10-million ha for food are needed by the end of this century

TABLE 13—ESTIMATED FUELWOOD CONSUMPTION IN 2004/05 (million tonnes)

Region/State/UTs	Fuelwood Consumption		
	Rural	Urban	Total
Northern Region			
Uttar Pradesh	37.0	10.0	47.0
Rajasthan	17.0	4.0	21.0
Punjab	3.5	0.5	4.0
Haryana	2.0	0.5	2.5
Himachal Pradesh	3.0	0.5	3.5
Jammu & Kashmir	2.5	0.5	3.0
Eastern &N-E Region			
West Bengal	9.5	0.5	10.0
Bihar	19.5	1.5	21.0
Orissa	13.0	3.5	16.5
Assam	11.5	1.5	13.0
Southern Region			
Andhra Pradesh	26.5	8.5	35.0
Karnataka	17.5	7.5	25.0
Tamil Nadu	20.0	10.5	30.5
Kerala	11.5	4.5	16.0
Western Region			
Madhya Pradesh	20.5	6.5	27.0
Maharashtra	22.5	5.5	28.0
Gujarat	10.0	3.0	13.0
Total	247	69	316.0

Source : *T N Khoshoo.*

TABLE 14—REQUIREMENT OF WOOD
(million tonnes)

Category	Requirement in 1980		Requirement in 2000		Additional requirement	
	m³	% of total	m³	% of total	m³	% increase
Fuel wood	188.600	87.5	225.000	78	36.4	19
Timber	22.720	10.5	46.755	16	24.0	106
Pulpwood	4.175	2.0	17.695	6	13.5	323
	215.495	100.0	289.450	100	73.9	34

Source : *T N Khoshoo.*

TABLE 15—AREA UNDER SOCIAL AND FARM-FORESTRY

State/UTs	1983–84			1984-85		
	Social Forestry Plantations to be raised (ha)	Farm-forestry No. of seedlings to be planted (millions)		Social Forestry Plantaions to be raised (ha)		Farm-forestry Seedlings supplied to public (millions)
	(A)	(A)	(T)	(A)	(T)	(A)
Andhra Pradesh	30,619	90.053	37,000	2,500	90.0	35.500
Assam	7,800	6.200	6,000	6,200	6.0	7.600
Bihar	22,238	29.135	22,000	22,100	30.0	35.100
Gujarat	27,851	195.400	30,525	30,846	210.0	187.050
Haryana	18,000	60.000	18,000	17,300	50.0	23.677
Himachal Pradesh	758	7.981	12,000	8,629	10.0	5.537
Jammu & Kashmir	6,149	9.981	8,650	1,652	10.0	4.418
Karnataka	20,000	100.000	22,000	17,415	120.0	64.457
Kerala	4,258	53.289	1,000	1,877	50.0	64.457
Madhya Pradesh	61,057	89.246	56,000	43,651	150.0	64.157
Maharashatra	49,452	98.364	46,000	46,028	70.0	39.733
Manipur	1,040	1.065	1,600	1,605	1.0	1.447
Meghalaya	1,960	0.631	2,500	3,745	1.0	1.415
Nagaland	4,236	8.805	5,000	6,640	2.0	4.610
Orissa	22,514	11.100	30,000	13,712	10.0	4.790
Punjab	13,968	47.514	18,000	17,889	40.0	27.295
Rajasthan	17,200	31.398	23,000	22,130	36.0	37.690
Sikkim	1,819	0.500	1,925	1,885	0.5	0.500
Tamil Nadu	28,768	45.981	40,000	14,838	27.0	13.999
Tripura	2,800	0.700	3,300	3,300	0.5	0.700
Uttar Pradesh	42,226	254.000	40,000	36,127	210.0	225.370
West Bengal	1.800	42.400	18,000	17,000	75.0	60.000
Arunachal Pradesh	602	0.469	1,600	521	0.2	0.209
Goa, Daman & Diu	293	0.973	200	—	0.2	0.947
Mizoram	4,000	0.500	5,000	5,000	0.4	0.500
Pondicherry	—	—	—	13	—	0.020
Andaman & Nicobar Island	107	0.037	100	370	—	0.049
Chandigarh	200	—	50	22	—	0.127
Dadra & Nagar Haveli	491	0.732	350	547	0.2	0.711
Delhi	150	0.165	200	198	—	0.332
Lakshadweep	—	—	—	—	—	—
	422,546	1,186.624	450,000	343,344	1200.0	9,43.319

A : Achievement; T : Target

Source : *Indian Agriculture in Brief*, 1985.

(Table 7). These may be possible provided the usable wastelands are reclaimed, developed and properly utilized. Introducing large-scale farming and afforestation on dryland is one aspect in developing these lands. Immediate reclamation of culturable wastelands (16.3-million ha), fallowlands other than current fallows (9.5-million ha), and utilizable barren or unculturable land (20.1-million ha) including the gullies and ravines (*c* 3.97-million ha),waterlogged (6-million ha), alkaline (2.5-million ha), saline and coastal sandy soils (5.5-million ha), and soils of shifting-cultivation (*c* 4.4-million ha) (Table 2&7) is the urgent need.

Afforestation, social forestry and farm-forestry are three important schemes under 20-point programme for developing forests. The total area planted from 1951–85 is *c* 6-million ha. An area of one-million ha was taken up during 1985–86. This gained momentum over a period of a decade and the results are encouraging (Table 15). Achievements during Sixth Five-year Plan are given in Table 16. The target for 1988–89 is 2-million ha and for 1989–90 is 3-million ha under these schemes. However, it is proposed to increase the tempo of afforestation to 5-million ha/year.

Several international organizations have also started extending help for various social-forestry projects (Table 17). The USAID is also actively involved in the social-forestry programme in Himachal Pradesh with income-generating and short-rotation species in reforesting 113,000 ha with approximately 160-million trees to ease the problem of fuel, fodder and timber, and prevent erosion, and conserve the soil and water, costing $330 million.

Recently, the International Labour Organization (ILO) in consultation with the Ministries of Labour and Human Resource Development, the Planning Commission, the National Wastelands Development Board, the Society for Promotion of Wastelands Development and the Self-employed Women's Association (SEWA) has sponsored a novel project to develop plantations for fodder and fuelwood on 240 ha of wastelands in Gujarat by employing rural women. It is complementary to the ILO project on 'Energy

TABLE 16—ACHIEVEMENTS DURING SIXTH FIVE-YEAR PLAN
(millions)

Particulars	1980–81	81–82	82–83	83–84	84–85
(i) Afforestation Total seedlings planted	0.847	1.319	2.078	2.418	2.636
(ii) Social Forestry Area planted (in ha)	0.153	0.254	0.375	0.422	0.467
(iii) Farm-forestry Seedlings distributed	—	0.441	0.897	1.187	1.275

Source :*India* 1986.

TABLE 17—SOCIAL FORESTRY PROJECTIONS IN INDIA DURING 1982–87 (ha)

State	Agency	Total cost (Rs in million)	Village woodlots	Farm forestry	Institutional lands	Community self-help	Canal	Road sides	Railway	Degraded forests	Total
Uttar Pradesh	World Bank	400	5,000	4,000	—	3,080	16,000	7,000	4,000	13,600	52,680
Gujarat	World Bank	654	37,400	76,000	—	—	2,000	31,600	3,400	30,000	180,400
West Bengal	World Bank	349	6,000	52,000	—	—	—	20,000	—	1,500	93,000
Haryana	World Bank	316	12,000	21,780	1,000	—	4,850	3,200	800	15,500	59,130
Jammu & Kashmir	World Bank	237	15,500	3,000	1,270	—	—	—	—	17,000	3,770
Karnataka	World Bank	592	8,000	10,000	—	—	2,000	18,000	—	60,000	188,000
Tamil Nadu	SIDA	450	132,000	39,200	—	2,250 (fodder)	—	6,075 km	—	—	162,300
Bihar	SIDA	400	—	20,000	—	3,500 (taser)	—	—	—	72,000	95,500
Orissa	SIDA	230	25,000	1,387	—	—	—	—	—	35,000	73,195
Maharashtra	USAID	564	5,250	2,750	—	—	—	28,198	—	37,000	61,387
Madhya Pradesh	USAID	470	48,000	—	—	—	—	15,450	—	—	63,450
Andhra Pradesh	CIDA	400	47,000*	102,000	—	—	—	—	—	42,000	191,000
Total		5,062	341,150	407,967	2,270	11,830	24,850	123,445	8,200	337,180	1,256,812
							+6075 km				+6075 km

*Tank foreshore

Note : Village woodlots are on community lands. Farm-forestry is on private lands.

Source : *V P Agarwala.*

and Rural Women's Work' supported by Netherlands. Some women's organizations are already reported to be active in West Bengal and Rajasthan attempting to reclaim degraded land for producing fuel and fodder. During the year of the Nehru Centenary Celebrations, Mahila Mandals have been formed in Himachal Pradesh, Jammu & Kashmir and Uttar Pradesh with the assistance of Nehru Implimentation Committee and Ministry of Environment & Forests to cover the barren hills with fodder-, fruit-, fibre- and timber-yielding plants to meet the local demands. Such projects not only create employment but help solve the problems of reclamation, and fuel and fodder.

The governmental efforts to bring the existing non-irrigated areas under irrigation have given unprecedented gains in agriculture. Consequently, the pressure on the forest-area has slightly reduced. If the proposals to bring more land under irrigation during the Seventh Five-year Plan are realized, the pressure may further ease. Utilizing the species such as *Casuarina* and *Prosopis* for fuel also have reduced pressure on forest-lands.

Part II

IMPORTANCE OF GREEN COVER

The precious reservoirs of plant and animal resources of the world are being destroyed at an alarming rate between 5,000,000 and 20,000,000 ha each year. This appalling rate of destruction will result in the disappearance of the forest-cover in the next 30 years, and all rainforests within *c* 80 years. The situation in India also is not much different. If such destruction continues, India will be devoid of any forest-cover within the next two decades. The prevention of further destruction coupled with the development of wastelands or wasted lands has, therefore, been undertaken as a priority programme.

Bare of vegetation and disturbed by cultivation, grazing, burning or bulldozing, the soil becomes vulnerable to damage caused by wind or water resulting in accelerated erosion, *i.e.*, washing away or blowing off the surface-soil, exposing the bedrock, in a short span of time. This loss of soil takes place much faster than the formation of new soil, and a kind of deficit-spending begins with the topsoil.

What keeps the soil in natural state and protects it from erosion is vegetation. If undisturbed, the soil is usually covered with dead and decaying leaves and different canopies of shrubs and trees or with a thick mat of grass. Whatever is the vegetation, it generally protects the soil from the force of rain or wind. The leaves and branches of trees and the cushion formed by the grass absorb the force of raindrops and the rootsystem holds the soil together and prevents the run off and consequent washing away the soil. Even during drought, the roots of established grasses, which extend several metres deep into the ground and also horizontally, help tie down the soil-particles and keep them from blowing off.

Man-made Erosion

The man-made soil-erosion is caused by the removal of vegetation for food-crops, fuel, buildings, roads, dam-building, communications, industrial establishments, etc. Continuous destruction of trees, bushes, grasses and other plants accelerates the erosion and degradation. Even the cultivated lands also are grouped under this category. In developing countries as India, where firewood is the chief source of energy, demand is fast outstripping the growth of new trees. Deforestation, particularly of slopes, to meet the demands causes destructive floods resulting in soil-erosion.

Overgrazing and the resultant erosion also lead to environmental problems. Overgrazing reduces the vegetative cover, eliminating the most desirable forage species first. This opens up the land to undesirable weeds, bushes and trees. This also sometimes leads to increased erosion and reduced soil-fertility. Even the availability of less-nutritious forage invites the goats and sheep which eat up just everything, including young saplings. Man himself destroys the soils, and demands more from the land than it can provide. The end-result is barren land, floods, salinity and alkalinity, duststorms and erosion. Hence, the responsibility for accelerated erosion squarely lies with man himself.

But, if the principles of soil-conservation are strictly followed, the process of erosion can considerably be slowed down, if not altogether halted. The method of conservation comprises safe-guarding all kinds of useful land including culturable lands from the vagaries of weather. Nearly, all land is useful for one or the other purpose. Some lands, which are flat, fertile and well-drained, are ideal for growing crops. Some others can be used for crops only if protected with conservation measures and still others should not be used for annual crops at all, but should be retained with grass and never be opened for grazing or should not be allowed beyond a limit. Other land, if left with trees, is practically erosion-proof. And much steep land with shallow soils should not be touched at all by man, but should remain in its natural state as it is a source for underground watertable and a home for wildlife. Good landuse is probably the best of all conservation practices.

The most inexpensive way to prevent soil from washing away or blowing off is to keep it covered. In most places, vegetation should cover at least 70% surface to provide adequate protection against erosion. If a cover of living plants is impractical, a cover of dead plants is definitely not. Many plants produce residues in addition to the parts that are harvested or grazed. These residues may be ploughed under, or left on the soil-surface as mulch, or practically mixed with the surface soil. Used in sufficient quantity, mulches provide a considerable protection to the soil much more than that received by clean-tilled land.

Mulches with crop-residues help reduce erosion, particularly from rain, in tropical countries. They can be of straw or stalks, other crop-residues, leaves of banana or sugarcane or palmfronds, etc., depending on what is locally available. When mulch decomposes, it also adds organic matter to the soil and prevents sealing or crusting of surface. Laid on the soil-surface or mixed into it, the mulch reduces the area exposed to the impact of raindrops, decreases the velocity of water by imparting roughness to the soil-surface, and reduces the quick run-off. This permits the water to penetrate through the soil more easily since there is no sealing or crusting on the soil-surface, and the status of moisture improves in soil. Check-dams and gully-plugging are also very helpful in preventing the water-erosion. Living mulches of grasses and legumes are also being tried between the rows of vegetables. These help to prevent crusting, control erosion, improve soil-tilth and conserve the moisture and create conditions conducive for biotic community.

The techniques for reducing wind-erosion generally differ from those for water-erosion. Trees can be planted at right-angles to the prevailing wind to break its force and also to provide shelter for the fields from sand and wind. The shelterbelts diminish the length of land open to windblowing and perform a function similar to that of terraces, gully-plugging and check-dams in controlling erosion from water. Large sand-dunes can be prevented from moving and covering the productive land by planting vegetative screens. Also, they trap the seeds of various plants and help in increasing the number and variety of plants.

To combat overgrazing, hardier and more nutritious species should be introduced for forage, and for harvesting and retaining at least a part of the forage for dry season. Degraded rangeland may have to be revitalized through reseeding. Where overgrazing has resulted in desertification, stern procedures are called for to halt the spread of desert and to begin reclamation. They include: (*i*) establishing new vegetation by seeding grasses and bushes, possibly with the aid of fertilizer and irrigation; (*ii*) stabilizing sand-dunes with binding plant-cover; (*iii*) constructing fences and other barriers to stop drift and to prevent animals; and (*iv*) retiring the land from the use by man and /or livestock at least till the plant-cover is sufficiently restored. These activities, singly or in combination, should lead to eventual reclamation of many a desertland, provided, of course, sufficient rainfall or irrigation is available.

Forests provide excellent cover on hillsides, but, when first established, young seedlings do not provide enough cover to prevent erosion. Like other crops, these should be planted on the contours or on terraces if the land is steep. Sloping-land, planted with trees or grasses, will erode less than if planted with cereals or pulses.

The legumes and also other species which can establish on various wastelands can improve the texture of soil by a variety of mechanisms which can be summarized as follows : (*i*) Dispersed nutrients in the soil-profile may be absorbed by plants and brought to the soil-surface in the form of leaf-litter; (*ii*) The activity of root-symbionts, such as bacterial association in nitrogen-fixing species, enriches nitrogen in soil; (*iii*) Increase in soil-organic matter from litter and root can stimulate microfloral and faunal activity, increasing the decomposition, mineralization and input of fixed nitrogen from free-living bacteria in soil; (*iv*) Rootsystem and the accumulation of organic matter can increase the porosity and retention of water beneath the trees, whereas canopy can reduce evaporation and moderate the surface temperature of soils; and (*v*) The trees can accumulate wind-blown materials and may decrease soil-erosion by increasing the population of plant and seepage of water, and improving soil-structure.

On wastelands, a cover with grasses, legumes, shrubs and trees should be established and maintained. If cutting and grazing are prohibited, the land may slowly recover on its own and may eventually even become productive.

Role of Grasses, Shrubs, Trees and Weeds

There are thousands of plants clothing the Earth, and none among them is considered useless. However small or big, all are important in the ecosystem. The selection of species for special purposes is based on the urgency of the need, priorities and the condition of the soil. They also should be able to accumulate nutrients, change the structure of soil and toxicity levels. If all conditions are normal or near normal with the availability of optimum moisture, most of the species easily establish in a short time and protect the soil and also provide biomass. On some types of soil, the conditions are so harsh that only hardy, quick-growing and suitable species have to be chosen for immediate success and to create conditions for succession.

For reclamation and afforestation of any type of wasteland, the choice of species of grasses and other plants should be such that the demand for inputs is the least and attention needed is negligible. They should have deep and large rootsystem and preferably be hardy, fast-growing and suckering. The trees should be coppicing, pollarding, and encouraging the growth of

Natural colonization of rocky wastelands in arid region

grasses and weeds under their canopy, besides being economically useful. Such species help in reconstructing the lost topsoil and bring the much-needed rest and respite to the soil from the forces of erosion. Once the seedlings start rooting, the land becomes more and more hospitable and becomes porous, absorbs water and retains it. This encourages better and greater growth and over the years it is easier to establish vegetation, leading to dramatic changes. When mulch is present, the topsoil forms, and the microflora, insects, birds and animals return, leading to an improved ecological balance. Such situation definitely improves underground aquifers, and dried-up springs may reappear.

Many grasses are perennials and their rootstocks survive under very adverse conditions, such as in sand, waterlogged areas and banks of various watercourses, and help in preventing erosion. The aerial portions of some perennial herbs dry out, leaving the underground living portions which produce shoots under favourable conditions and form a cycle. Several herbs belonging to various families grow near the seashores, which can be employed for fixation of sand-dunes and reclaiming salty areas; plants of such genera as *Agave*, *Casuarina*, *Syzygium* and *Yucca* with scaly, glossy or waxy surfaces are also highly suitable. These are generally more useful in reclamation and afforestation as the dried portions form mulch and part of topsoil, and the underground portions hold the soil. Members of certain families, such as *Apiaceae*, *Asclepiadaceae*, *Asteraceae*, *Chenopodiaceae*, *Cyperaceae, Euphorbiaceae, Fabaceae, Poaceae* and *Portulacaceae,* produce stolons and disperse billions of seeds. Many are very hardy and drought- and frost-resistant and establish with minimum moisture and under very adverse conditions. These seeds act as seedbanks which germinate under favourable conditions. Since the seeds are produced in large numbers and are easily dispersed, and self-sown, such families as these are important for reclamation. They produce large biomass and hold the soil together. The biomass gives sufficient cover and mulch, and creates favourable microclimate. The stolons or rootstocks of many grasses and sedges and other plants continue to grow underground, flushing out the aerial portions at intervals, and prevent erosion.

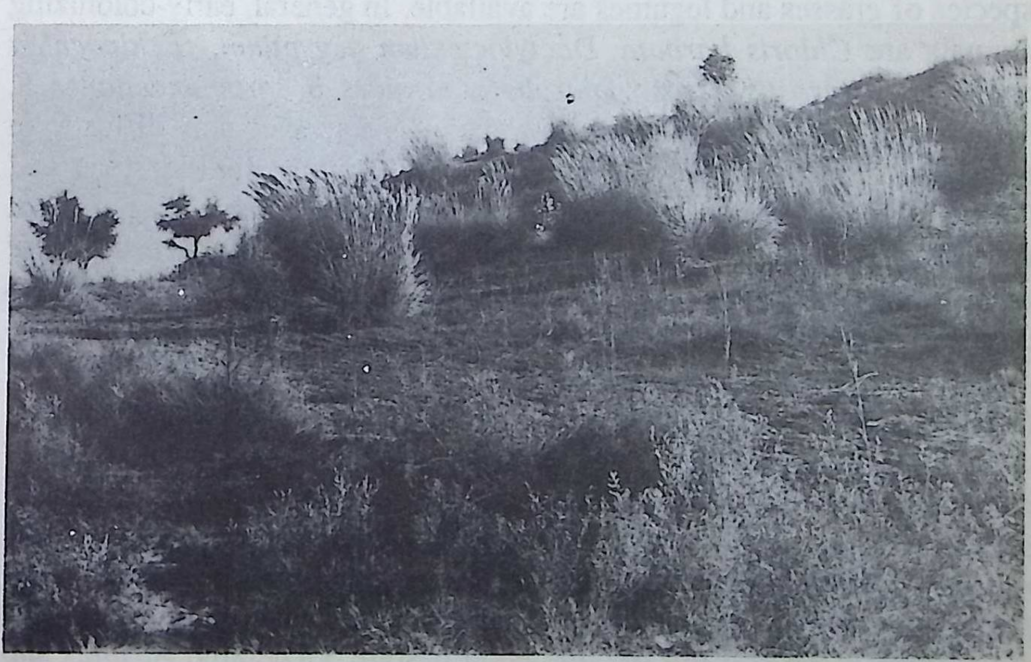
The silvipasture is almost similar to agroforestry and is the most useful system for wastelands, ravines and sand-dunes. The interspaces of forest-trees can be utilized for growing nutritious grasses. Compatibility between the grasses and trees is essential. The tree should be light-crowned and must also be able to yield fuel, fodder, timber, etc. Some such important trees are *Acacia nilotica* ssp. *indica, A.tortilis, Albizia* spp, *Anogeissus* spp, *Dalbergia* spp, *Eucalyptus* spp, *Grewia tiliifolia, Hardwickia binata, Leucaena latisiliqua, Ougeinia oojeinensis, Populus* spp, *Prosopis chilensis, P. cineraria, Quercus* sp, and *Terminalia bellirica.* Some of the promising grasses are *Cenchrus ciliaris, C. setigerus, Chrysopogon fulvus, Panicum maximum* and *Pennisetum pedicillatum.* Certain grasses, such as *Arundo donax, Imperata cylindrica (I. arundinacea)* and *Panicum repens* are excellent soil-binders and prevent erosion. Such combinations not only prevent erosion and improve the soil but produce much-needed fuel, timber, and fodder. But, the removal and/or degradation of vegetative cover along with roots, when the plants are able to coppice, has tremendous impact on the productivity of land.

Also, some tree- and shrub-species of families, such as *Aceraceae, Betulaceae, Bombacaceae, Caesalpiniaceae, Casuarinaceae, Dalbergiaceae, Mimosaceae, Moraceae, Myrtaceae, Pinaceae* and *Proteaceae* produce large number of seeds and these are dispersed through several methods. Such families help in building up natural forests through natural regeneration. Here too, the seeds act as seedbanks in soil which germinate under favourable conditions. Trees, being tall, trap the seeds of other plants from wind more than shrubs or herbs and help in propagating and increasing the populations in the ecosystem. They also provide shelter and food for birds and other animals which in turn disperse the seeds, helping to improve the ecosystem with varied species; birds and animals provide manure which also acts as mulch.

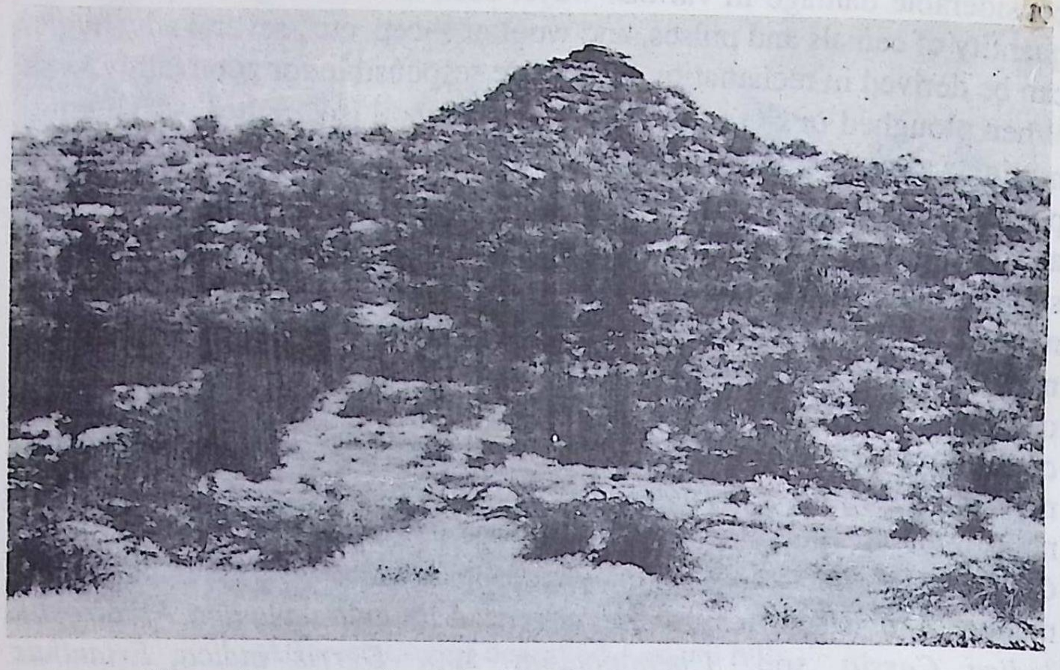
Afforestation of degraded Aravalli hills

But, this is a slow process. Hence, the interference of man is sometimes necessary to quickly upgrade the ecosystem and climax vegetation, which have greatly been damaged, by introducing appropriate flora from grasses to trees or *vice versa* with proper protection. When man intervenes, it may be gradual as in nature from herbs to trees or it may be accelerated in reverse, trees occupying the first place in programmes, depending upon the urgency and necessity. When more tolerant species are planted on degraded soils, they create better conditions in due course of time for less-tolerant species to adapt to alkaline, saline, waterlogged or sandy soils. This not only improves the base for greening but quickly brings in the expected returns in meeting the demand for fuel and fodder. It is reported that the much-malinged, quick-growing and -spreading *Prosopis* spp have retarded the destruction of forests for fuel, besides helping in reclamation. The fast-growing species, either trees or shrubs, can regularly be coppiced for fuel and fodder and yet can prevent erosion. The yield of biomass can also be optimized. Regular and periodic coppicing should encourage new flushes for more biomass.

Apart from the selected species and grasses, hundreds and thousands of weeds, shrubs, and trees which are natural colonizers are growing on different types of soils and these are also helpful in controlling erosion and degradation. But, the natural process is so slow that by the time the flora establishes they are either grazed or felled. Though the weeds cause considerable damage in various ways, such as reducing the quality and quantity of cereals and pulses, and wool of sheep. etc., several advantages can be derived in reclamation. These are responsible for good cultivation. When ploughed *in situ* as green manure, the soil is enriched with humus, nutrients and moisture. Excellent compost can be made from most of these plants. In addition, the leguminous weeds improve the status of nutrients and help in fixing nitrogen. Several herbs and shrubs, such as *Calotropis* spp, *Datura* sp, *Dodonaea viscosa, Lantana* spp and *Tephrosia purpurea,* may not be aesthetic, but, in reality, they are good soil-binders and green manures, yield mulch, and give protection and stability to soil and seedlings of other plants. Likewise, the most disliked *Croton bonplandianum,* a very cosmopolitan, easily-regenerating, gregarious weed, is a good green manure, and profusely grows on saline and alkaline soils. *Cassia* spp also are not only good green manures but nitrogen-fixers and good soil-binders. *Cleome chelidonii* improves the yield of paddy. *Opuntia* sp makes a good manure. *Acacia* spp, *Achyranthes aspera, Adhatoda zeylanica, Azadirachta indica, Cassia* spp, *Chenopodium* spp, *Derris indica, Erianthus munja, Ipomoea carnea* ssp. *fistulosa, Prosopis* spp, and *Saccharum spontaneum* need little or no input but check the deterioration and erosion of soil and provide large biomass; they also provide the much-needed mulch and organic manure and other products. In wetlands, where



Duny vegetation of *Prosopis–Saccharum* type showing natural regeneration



Natural regeneration of arid rocky and semi-rocky areas

it is not possible to have a green fallow or catch-crop, weeds form a rotation with paddy and prevent loss of nitrates.

Saline and alkaline lands can be developed for pasture as several native species of grasses and legumes are available. In general, early-colonizing annuals are *Chloris barbata*, *Dactyloctenium aegyptium*, *Echinochloa colonum*, *Eragrostis viscosa*, *Sporobolus airoides*, *S. coromandelianus*, *S. helvolus*, and *S. marginatus (S. arabicus)*. The species may differ from region to region and depend upon local conditions. In Rajasthan and Gujarat, the near climax species include *Cenchrus ciliaris*, *C. setigerus*, *Cynodon dactylon*, *Dactyloctenium sindicum*, *Diplachne fusca*, *Eleusine compressa*, *Sporobolus helvolus* and *S. marginatus;* the associated legumes are *Cassia tora*, *Crotalaria medicaginea*, *Indigofera cordifolia* and *Rhynchosia minima*. For black cotton-soils of peninsular India, the species are *Bothriochloa pertusa*, *Chloris bournei*, *C. virgata*, *Dichanthium annulatum* and *Iseilema laxum* along with *Alysicarpus rugosus*, *Indigofera endecaphylla* and *Sesbania sesban*. For coastal and deltaic areas, *Brachiaria distachya*, *Eleusine indica*, *Eragrostis coarctata*, *E. nutans*, *Panicum repens* and *Zoysia matrella* along with *Crotalaria* spp, *Desmodium* spp, *Phaseolus* spp and *Trifolium* spp are recommended. Such combinations not only improve the soil but provide good pasture. Generally, *Atriplex* spp (SALTBUSH), *A. canescens* and *A. confertifolia*, *A. nummularia*, *A. nuttallii*, *A. semi-baccata*. and *A. vesicaria*, perform well on such soils as in desertregions; *Kochia* spp are also useful. Several other grasses and legumes, other fodders and crops have also shown tolerance. These lands can also be planted in succession with suitable shrubs and trees.

Reclamation of waterlogged areas is generally based upon the principle of succession. They can be stacked with pioneer hydrophytes, followed by economically useful *Clinogyne dichotoma, Cyperus corymbosus, C. pangorei, Typha* spp, etc. These build up the substratum for higher plants on which species of forage-value, such as *Brachiaria mutica* (*Panicum muticum*) (PARAGRASS), *Digitaria* spp (PANGOLA-GRASS), *Panicum maximum, Paspalum dialatatum* along with *Alysicarpus rugosus*, and *Sesbania sesban*, can be grown; also when *Dichanthium annulatum* 'IGFRI-495', *Eulalia trispicata* and *Iseilema laxum* are grown with *Alysicarpus rugosus, Sesbania sesban* and *Vigna* spp, they not only improve the soil but improve the quality of herbage. *Cynodon dactylon, C. plectostachyum, Dichanthium cariosum, Panicum antidotale, Pennisetum polystachyon, Sehima nervosum* and *Urochloa mosambicensis* are suitable for waterways, banks and bunds. Such soils can also later be planted with waterloving trees which yield wood, fuel or fodder, such as *Barringtonia acutangula, Dalbergia latifolia, Eucalyptus robusta, Lagerstroemia speciosa, Populus euphratica* and *Salix tetrasperma.*

Certain grasses and legumes are very versatile in adapting to various types of climates and soils and rainfall. *Cenchrus ciliaris* '3108', *Dichanthium*

Halophytic vegetation

annulatum and *Lasiurus sindicus* are particularly suited for extreme conditions, and *Panicum turgidum* for sand-dunes; legumes, such as *Crotalaria burhia, Dolichos lablab* var. *lignosus, Indigofera cordifolia* and *Rhynchosia minima*, may be suitable for mixtures.

Under sandy or sandy loam, with 750 mm rainfall, *C. ciliaris* and *D. annulatum* can be combined with *Alysicarpus rugosus, Dolichos lablab, Indigofera endecaphylla* and *Mucuna deeringiana.* For light soils, *Chrysopogon* sp, *Cynodon dactylon* and *D. annulatum* can be planted. For black cotton-soils, *Chloris bournei, C. gayana* and *D. annulatum* and *A. rugosus, Aeschynomene indica* and *Desmodium diffusum;* for red loams and laterites, *Centrosema pubescens, Pennisetum clandestinum, P. maximum, P. pedicellatum, P. polystachyon, Phaseolus atropurpureus, Stylosanthes guyanensis* and *S. humilis;* for hills up to 2000 m, *Arundinella nepalensis,Cymbopogon coloratus,Dichanthium bladhii Eulaliopsis binata, Heteropogon contortus, P. clandestinum, Phalaris aquatica* and *Themeda anathera*, and legumes *Centrosema pubescens, Desmodium* sp, *Pueraria phaseoloides, S. guyanensis* and *S. hamata;* for above 2000 m, *Bromus unioloides (B. catharticus), Dactylis glomerata, Lolium perenne, Lupinus angustifolius, Medicago sativa, Phalaris tuberosa, Trifolium repens* and *T. pratense* are suitable. These can be succeeded by shrubs and trees. Combinations can also be found out basing upon the local flora.

The bushy forests and deforested lands should be protected from grazing, and grasses, such as *Dichanthium annulatum, Panicum antidotale, Saccharum bangalense* and *S. spontaneum*, should be planted along with fast-growing trees as *Eucalyptus* spp and *Leucaena latisiliqua.* Barren lands with overgrazing and road- and land-cuttings can also be planted with *Cenchrus ciliaris, C. setigerus, Cynodon dactylon*, etc., besides the species already mentioned.

The weed-flora also indicates the nature of soil, fertility and the type of soil on which they grow. Also, many weeds serve as food for humans and cattle during famine and scarcity; and some may also be ornaments. As for example, *Cymbopogon caesius* indicates poor, light soils; most sedges, ill-drained soils. Weeds, such as *Desmostachya bipinnata, Dichanthium annulatum, Pseudoraphis spinescens (Andropogon squarrosus), Sporobolus nervosus (S. stocksii)* and *S. marginatus* and *Suaeda maritima*, are common on alkaline soils; *Alternanthera sessilis, Amaranthus* sp, *Chenopodium* spp, *Cynodon dactylon, Digera muricata, Portulaca oleracea, Rumex acetosella, Spinacea oleracea,* etc. are eaten as potherbs. Identification of local flora for the specific soils is thus very important. Some of these weeds, such as *Asystasia gangetica, Clitoria ternatea, Gloriosa superba, Portulaca* spp and *Vicoa indica* also possess aesthetic value, having beautiful ornamental flowers.

Role of nitrogen-fixing Plants

The development of wastelands is an intricate process. Mostly, these are skeletal soils lacking in humus; these cointain toxic elements and the status of nutrients is low. Natural colonization and its development into an ecosystem are slow and stochastic processes. Hence, assistance to quicken the reclamation of wastelands is essential. The four important stages of development include: (*i*) selection of suitable species; (*ii*) accumulation of nutrients both in plant and soil; (*iii*) changes in structure of soil; and (*iv*) changes in toxicity levels. Herbaceous legumes are one group of primary colonizers along with grasses, etc. and highly useful in developing the wastelands because of their ability to enrich the soil. Many other leguminous and non-leguminous, nitrogen-fixing species also meet the needs of reclamation, fodder and fuel. Legumes form one of the largest groups in the plant-kingdom and are cosmopolitan with a wide range of adaptability and are well-represented in tropical, subtropical and temperate regions; they are also commonly found under semi-arid and arid conditions. The ecological success of these legumes is due to their unique ability to form tubercles or nodules in the rootsystem in association with the soil-borne bacterium (*Rhizobium* spp or *Bradyrhizobium* spp). Initiation, development and function of nodules comprise intricate biochemical and biophysical processes between the plant and the bacterium. The effective nodules are pinkish and these fix atmospheric nitrogen utilized by plants.

The capacity to fix atmospheric nitrogen allows legumes to establish and grow in nitrogen-deficient soils. *Prosopis chilensis* var. *glandulosa* is reported to fix up to 60 per cent of its annual requirements of nitrogen, *c* 30 kgN/ha/year; and 110 kg/ha/year were reported for *Leucaena latisiliqua*; *Gliricidia sepium* also was reported to fix very high amounts of nitrogen.

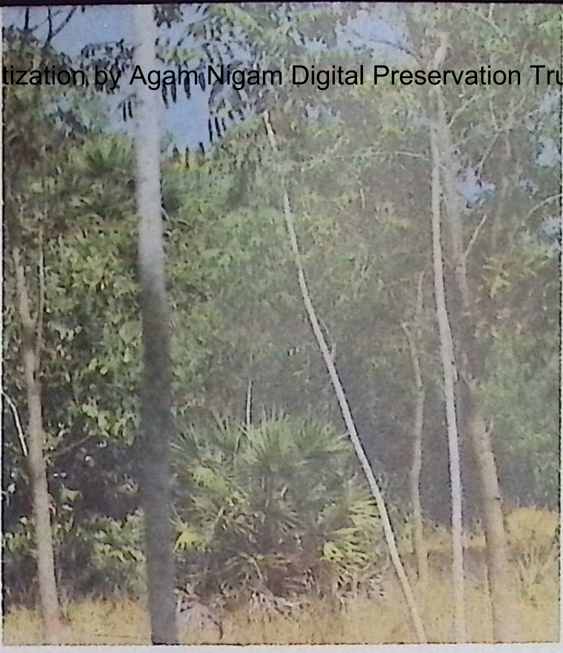
Although leguminous trees have traditionally been utilized for food, fodder, timber, fuel, and shade- or cashcrops, it is only recently that these species have systematically been introduced into new fields. The success of these introductions depends, to a large extent, on the host–bacteria relationship. The nitrogen-fixation is limited due to many factors, the most important being the lack or inefficiency of rhizobia in the environment in which the legumes are growing. The rhizobia for most leguminous trees are ubiquitous and, therefore, do not need inoculation, but some species, such as *Leucaena latisiliqua* and some *Acacia* spp, require specific rhizobia which may not occur at all sites. Therefore, inoculating such legumes with bacteria possessing high nitrogen-fixing ability contributes towards the success of legumes in introduced areas.

The leguminous plants require little or no nitrogenous fertilizer; they are pioneers on nitrogen-deficient, barren sites, wetlands and sand-dunes and their residues leave the soil enriched with nitrogen. These legumes revegetate marginal terrian, halt erosion and provide a protective ground-cover under which the native or conventional forestry can regenerate. Therefore, the leguminous trees are receiving increasing attention in agroforestry and afforestation programmes. Woody legumes are often an important component of arid and semi-arid ecosystems. Many of these trees and shrubs have the ability to develop a deep rootsystem and fix atmospheric nitrogen; they withstand water- and salinity stresses. These characteristics, which favour survival and high productivity in arid environments, have increased the interest in the cultivation and management of woody-leguminous stands for fuel and forage and for stabilization and improvement of soil. A list of species reported to fix nitrogen or aid in fixing nitrogen, which may be suitable for reclaiming wasteland and/or cropping, and possess other utilities is given in Appendix 10.

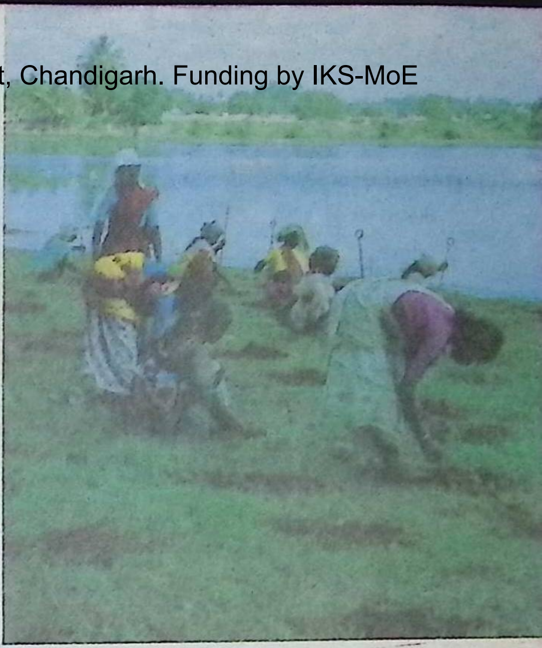
Besides the leguminous plants, some non-leguminous plants *(Alnus, Elaeagnus, Hippophaë, Trema,* etc.*)* also help in fixing nitrogen and form nodules with *Frankia* sp.; and *Diplachne fusca* is reported to be associated with nitrogen-fixing *Klebsiella pneumoniae.* These are also useful for various other purposes. Amongst the potential grain and vegetable legumes, *Lupinus angustifolius, Voandzeia subterranea, Cyamopsis tetragonoloba, Canavalia* spp, etc. can also serve the purpose of reclamation.

The BLUE LUPINE, *Lupinus angustifolius*, a bushy annual, native to the Mediterranean region, introduced into India, grows well on infertile, acid, sandy soils. It serves as a feed and is also grown for green-manuring, besides providing an excellent cover against soil-erosion. The smooth, white seeds resemble peas and taste likewise. Currently, they are used in rations for poultry, pigs, and cattle. They have the potential of becoming as significant a food for humans as soybean. Low-alkaloidal cultivars with sweet seeds have been found.

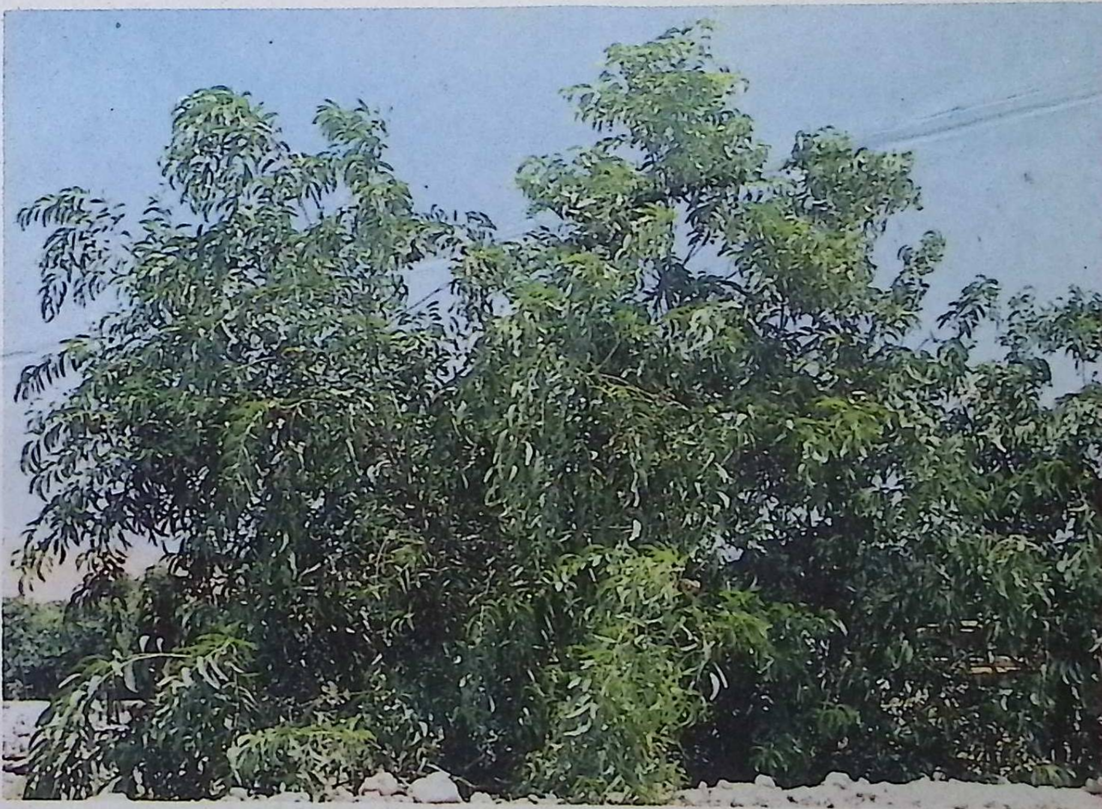
The BAMBARA GROUNDNUT, *Voandzeia subterranea,* introduced into India, can thrive in arid soils where groundnut fails. Like groundnut, it forms fruits underground. The seeds, although having less oil and protein than groundnut, are a well-balanced and tasty food, with a calorific value equal to that of a high-quality grain.



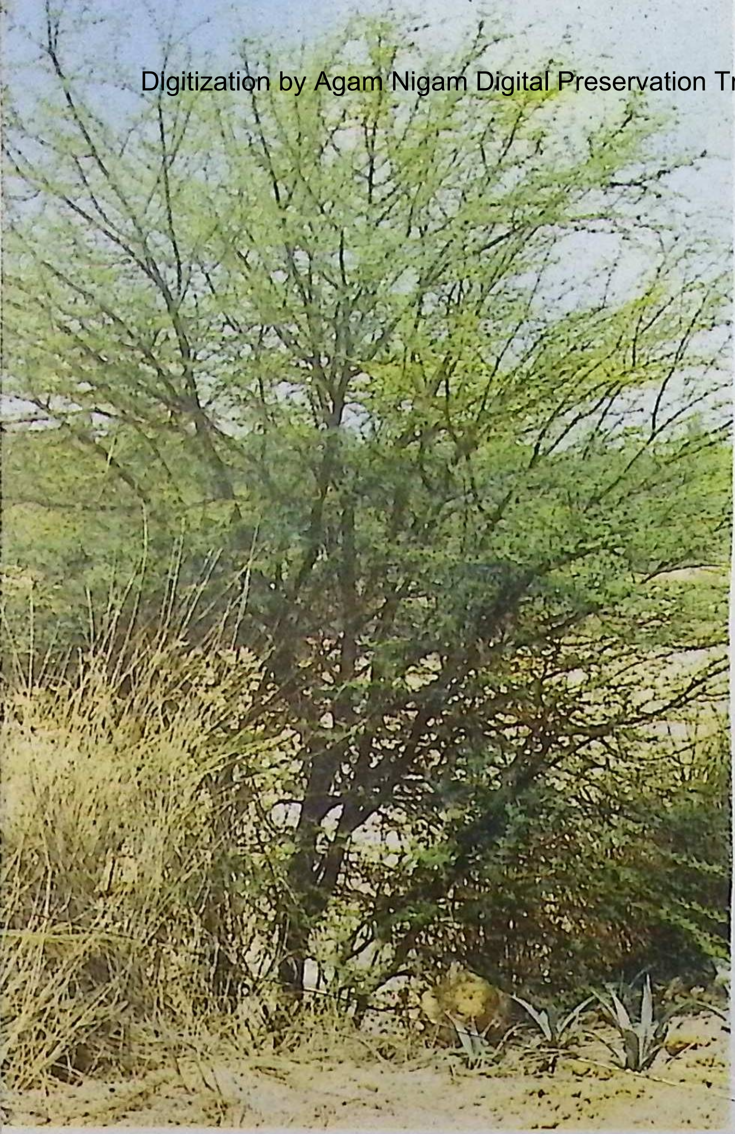
Mixed plantation



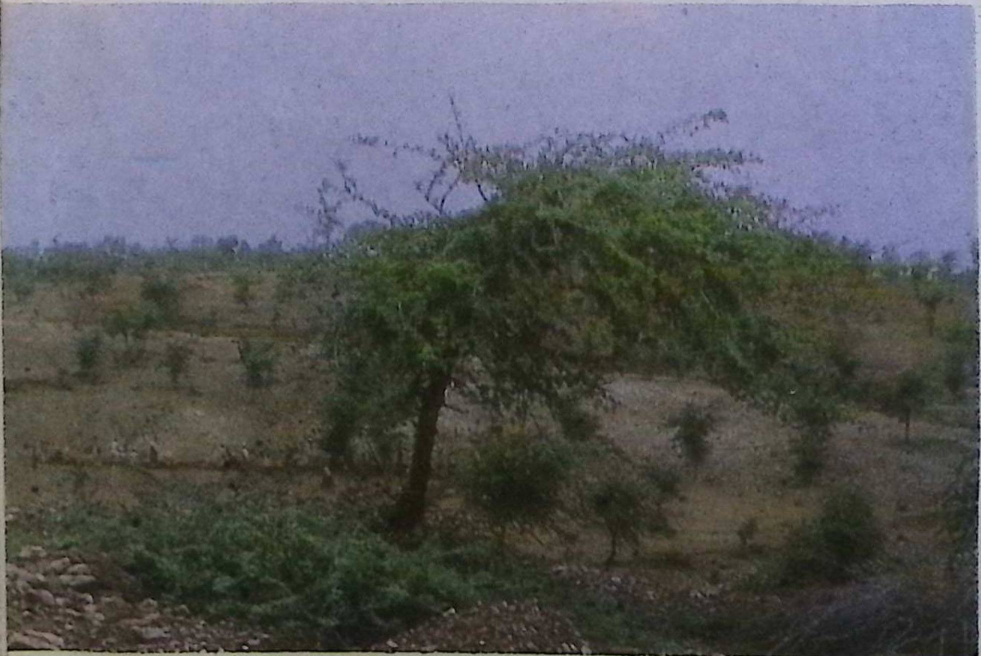
Acacia nilotica—Planting on tankbed



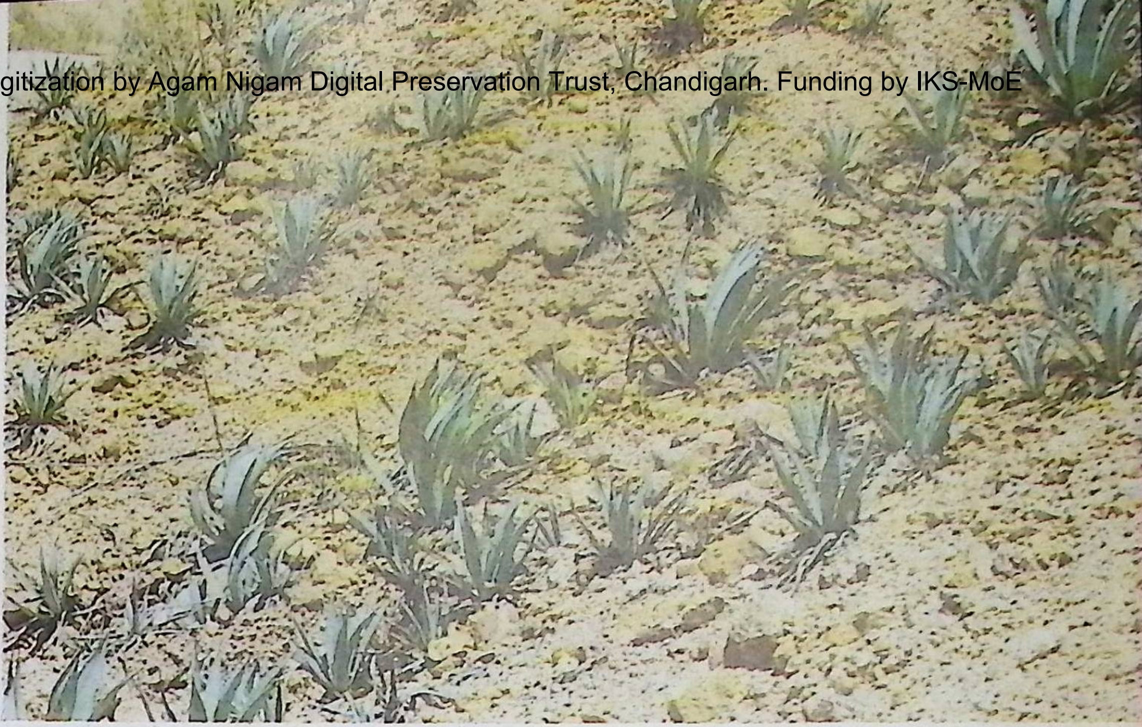
Acacia auriculaeformis



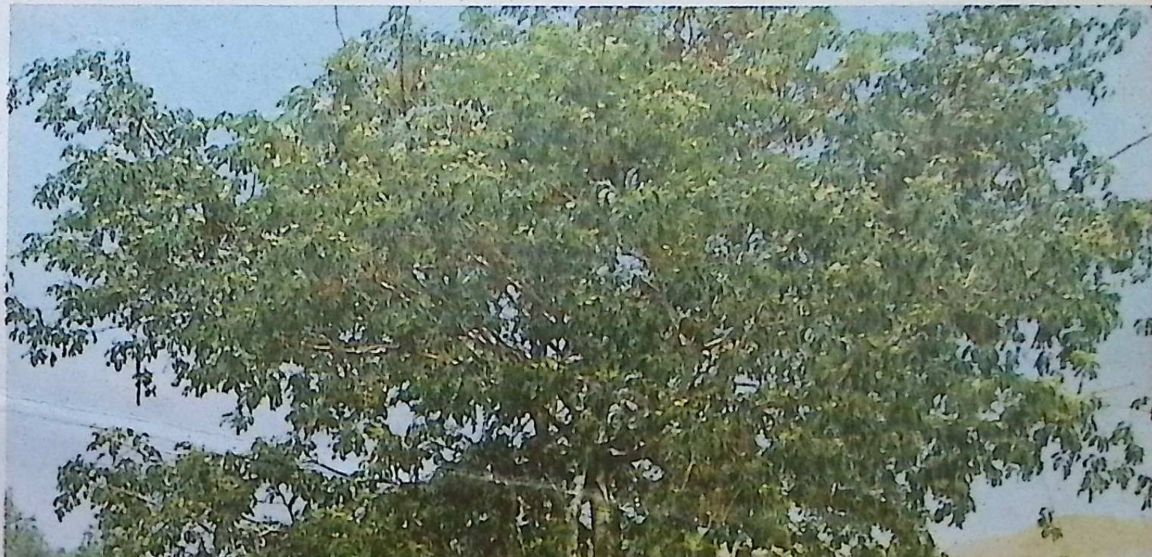
Acacia nilotica



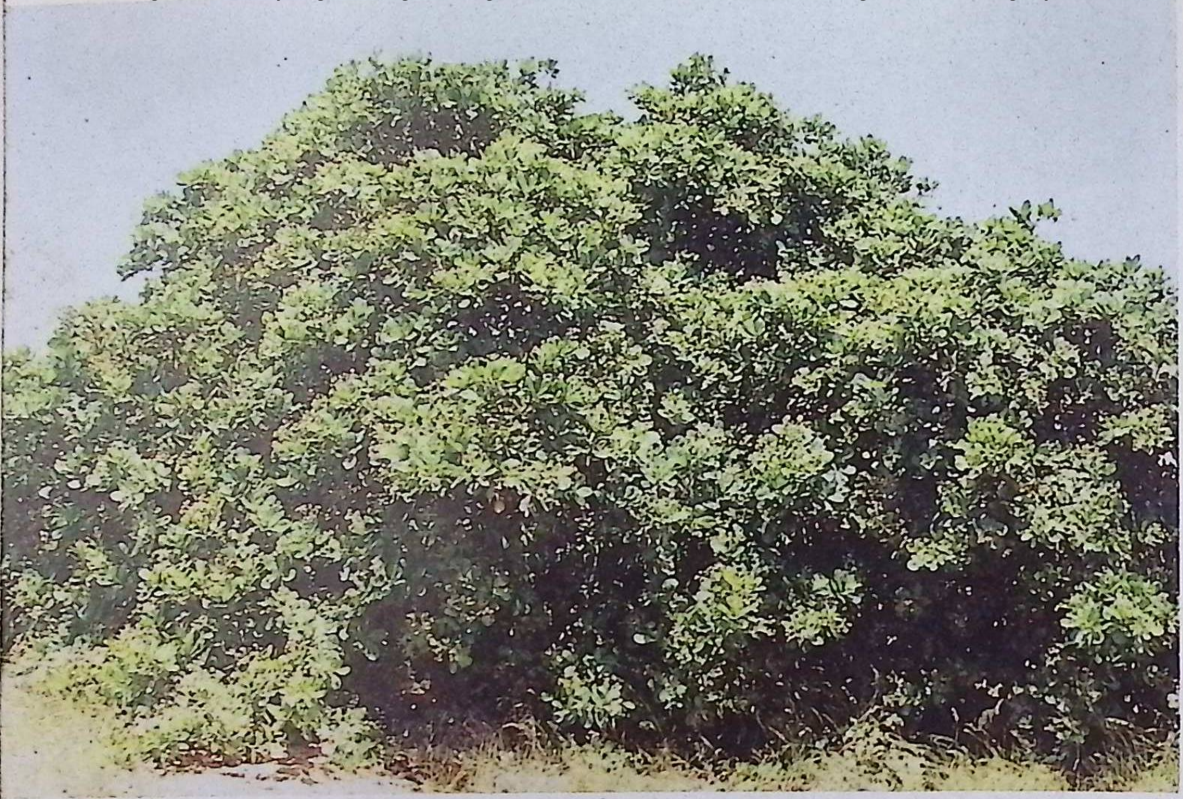
Acacia leucophloea



Agave mexicana

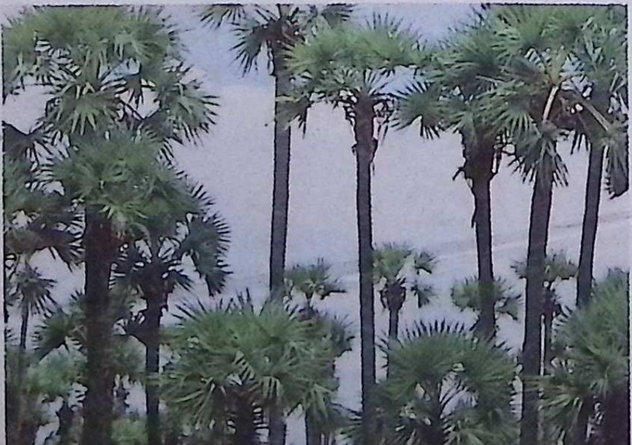


Albizia lebbeck



Anacardium occidentale

Azadirachta indica—Plantings on red, rocky soil



Borassus flabellifer—Shelterbelts for agricultural lands

The Clusterbean, *Cyamopsis tetragonoloba* is a bushy, drought-resistant plant and is tolerant to alkaline soils. It is cultivated in India for the edible pods and fodder, as a green manure, and for preventing soil-erosion. The gum extracted from its seeds is used in food, pharmaceutical, and mining industry; and is also used in the paper, cosmetic and explosive industry.

Species of *Vicia* Linn., commonly called Vetches, are extensively used in temperate regions as cover-crops and green manures. Their matting rootsystem prevents erosion besides improving the texture and physical conditions of soils by adding organic matter and fixing nitirogen. They can be used as fodders; seeds as feed; and some are used as common vegetables. They make good pasture and silage. Other crops, such as *Cajanus cajan*, *Cicer* spp, *Crotalaria anagyroides*, *Dolichos* spp, *Phaseolus* spp, and *Vigna* spp *(V. aconitifolia, V. radiata, V. trilobata)* are all highly valued for nitrogen-fixation, besides fodder and pulses, and are employed in reclamation.

Role of Energy-crops

Besides nitrogen-fixing plants, the energy-crops are another group of plants which are gaining importance in reclamation of wastelands in recent times. This is because of: (*i*) the dwindling non-renewable natural resources of fuel, (*ii*) the steep increase in the demand for fuel, and (*iii*) the rapid loss of forests which are the source of fuelwood, leading to degradation of soil. One of the alternatives to meet the demand is to identify suitable renewable resources of fuel to supplement natural petroleum and which, in future, can meet the major share on a sustainable basis. Renewable resources of fuel-crops should be such species which can grow on marginal lands, and other degraded and non-productive lands which cannot support traditional crops, and do not require heavy inputs.

Plants yield complex organic substances that contain many compounds which may be used as a source for liquid-fuels and/or for chemical products. The conversion of these products into fuels or chemicals has conceptually become feasible. The exudates and extractives are energy-rich and may be exploited as renewable sources of energy. These plants are known as petrocrops, since they can serve as substitutes for or supplement to petrochemicals. Selected species should not only possess energy-rich organic substances but should have rapid growth and should be able to adapt to a given agroclimate with high yield.

The energy-rich exudates and extractives can be classified into: (*i*) latex, (*ii*) vegetable oils and waxes, (*iii*) resins, (*iv*) essential oils, and (*iv*) tannins and phenolic compounds. Out of the above five groups of exudates and extractives, latex and vegetable oils and waxes are important as a source for petrochemicals. Resins and essential oils, which are highly combustible, have also been considered for incorporation into formulations of fuel for automobiles. However, at present these resources cannot compete with petroleum or allied products on commercial basis.

Latex: The discovery of utilizing latex, having energy-rich hydrocarbons with low molecular weight, as petrofuels has opened new possibilities for farming petrocrops on a renewable basis on wastelands. The latex with high content of resin is also suitable for many applications, such as adhesives, protective coatings, plasticization activity and for improvement in the flexibility and mechanical workability of plastics. Further, these latex-yielding plants prefer semi-arid and arid conditions, and thus do not compete with the traditional crops and do not need much inputs.

The latex-yielding plants belong to many families, such as *Apocynaceae, Asclepiadaceae, Euphorbiaceae, Moraceae* and *Sapotaceae*. The *Euphorbia* spp (*c* 2000; latex–30% light hydrocarbons; mol wt–20,000 instead of 2 million) are xerophytic and cosmopolitan in distribution, chiefly being found in tropical to subtropical and warm-temperate regions, and exude latex. They inhabit dry places and grow on barren rocky glades, ledges, rocky open woods, gravelly and rocky slopes, ravines, rocky canyons, mesas, clearings, exposed limestone rocky glades, open-exposed situations, open sandy and gravelly areas, and other waste places. Some of the perennial xeric euphorbias are often abundant and gregarious on such open, dry areas because (*i*) of their ability to rapidly spread with their underground creeping and forking rootstocks thus forming extensive colonies; and(*ii*) livestock generally avoids the plants as some are spiny and have bitter taste, cause irritation and possess moisture- and nutrient-stress.

Several *Euphorbia* spp have been found to be potential petrocrops. These hardy plants can be used for reclaiming and revegetating the wastelands, ravines and arid and semi-arid, saline and alkaline areas; *E. lathyris* and *E. tirucalli* have shown promising results. Attempts have been made to grow different petrocrops at the National Botanical Research Institute, Lucknow. The yields of hydrocarbon crops are as follows: *Euphorbia antisyphilitica*–12.5; *E. tirucalli*–8.2; *E. lathyris*–2.5 and *Pedilanthes tithymaloides*–up to 25.6 tonnes/ha. *E. lathyris* has not shown the expected promise because of hot summers and humid months which caused a serious disease in the plants; also they did not flower and seed since chilling is required.

If water is removed from the latex, the resulting material is a liquid-oil. These hydrocarbons, when subjected to catalytic cracking, yield various products identical to those obtained from cracking naphtha. The chemical similarity of the hydrocarbon material to petroleum makes its processing feasible even in the present-day refineries.

The other potential petrocrops are *Calotropis procera* and *Asclepias curassavica*. The former is widely distributed in arid and semi-arid regions and grows without inputs under very adverse conditions, and easily propagates from seeds. It is commonly found during hot months in open, waste, dry places, often gregarious along the railway embankments, sandy river-beds, roadsides and forest-clearings; coppices most of the time and resists fire. *C. procera* can yield 3.7 tonnes/ha/year and appears to have high productivity of latex (1.65 barrels/ha/year), the gross heat content being comparable to that of *Euphorbia lathyris*. *Parthenium argentatum* yields latex and is also reported to be a possible petroplant. Many species of *Asteraceae* also contain latex and may be useful as petrocrops.

Vegetable Oils and Waxes: Oils and waxes are abundant in seeds; and waxes are normally rich on the surface of leaves and stems, and are very similar and consist of fatty acids and their derivatives. Promising new oil- and wax-yielding species have been reported and some of these can be utilized as a cheap source for petrochemicals, and long-chain aliphatic compounds. Vegetable oils also have great potential to be used as liquid-fuel or as a source of hydrocarbons. They are combustible and some of them will combust in diesel-engines or, may be mixed in any proportion with diesel and can be supplemented to diesel. Some of the non-edible oilseeds, which can be cultivated on wastelands, include *Azadirachta indica, Derris indica, Madhuca longifolia* var. *latifolia, Salvadora oleoides*, etc. but *Calophyllum inophyllum, Jatropha curcas, Ricinus communis, Sapium sebiferum, Schleichera oleosa* and *Simmondsia chinensis* are considered more productive. Conversion of jojoba, castor and other vegetable oils into hydrocarbon fuels has already been demonstrated.

The oil from *Jatropha curcas* is also an effective substitute fuel for diesel-engines. *Jatropha* spp are highly adaptable to various kinds of soils. They grow well on moderately sodic and saline, degraded and eroded soils and propagate rapidly. They can be planted on marginal lands without affecting the existing agricultural set up and are a good source of energy. *J.curcas* begins to yield nuts in 4–5months and can live for 50 years. The kernels form 60–68% of seed and yield a semi-drying oil (46–58%). It is estimated that 2000-kg crude oil can be obtained per hectare having *c* 500 plants. The oil has a good potential for burning. Even the seeds burn for a considerable period of time and emit energy.

Jojoba (*Simmondsia chinensis*) has successfully been introduced and now cultivated in the semi-arid and subhumid climates in the western and eastern regions of India. It grows on soils with marginal fertility and where rainfall ranges from 125 to 450mm and tolerates drought and high temperatures up to 45°C. The seeds yield a light, gold-coloured, non-volatile and non-toxic oil (42–60%); it does not contain resin, tar or alkaloid. It has high viscosity index, and does not oxidize. Hence, it does not become rancid and can be stored for a long time. It can withstand temperatures as high as 300°C. It is the only vegetable oil which is not a triglyceride but a mixture of two monobasic esters of two long-chain alcohols. Linearity and close-range composition are probably the two properties which give jojoba its unique characteristics. Besides being a good friction-modifier, the oil also exhibits anti-wear and extreme-pressure characteristics. This unique blend of properties contributes to its vast potential in different industries, now consuming petroleum and spermwhale oil. A formulation using jojoba oil as a base-stock for two-stroke engine-oil has been developed. This can be substituted to spermwhale oil in cosmetic industry.

So, the spermwhale can have a sigh of relief from sure extinction!

Resins: These include a number of terpenic compounds and their derivatives. The resins are usually found in special cells and canals in different parts of a wide variety of plants. The most important commercial resins are collected from the *Pinaceae*. These are normally present as volatile oils (turpentine) and non-volatile resins (rosin). These resins may form a source for synthetic rubber and other polymers. Since turpentine is a highly combustible chemical, consideration has also been given to the incorporation of turpentine into various formulations of fuel for automobiles. Besides *Pinus* spp, the other promising resin-yielding plants include *Dipterocarpus* spp, *Vateria* spp, *Canarium* spp and *Shorea* spp.

A list of potential hydrocarbon-yielding plants, suitable for reclaiming wastelands, is given in Appendix 11.

Selected Economic Plants for Reclaiming Wastelands

ACACIA Mill. (*Mimosaceae*)

Thorny shrubs or trees or sometimes climbers; warmer and drier arid regions of world, chiefly in Australia and Africa; 36 spp in India.

Several exotics have been introduced for reclamation and afforestation of various wastelands and for agro- and social forestry. They control wind-, water-, and rain-erosion; some species are salt-resistant, whereas some others fix nitrogen. *Acacia* spp yield a wide range of products, such as gums, tannins, timbers, perfumes, fodder and feed. These species are invaluable for planting on bare lands and sand-dunes. They thrive in the most severe environmental conditions and can be planted on sodic, alkaline soils, etc. Once establish, they can create conditions suitable for other species. These species are normally propagated from seed.

A. auriculaeformis A. Cunn. AUSTRALIAN WATTLE

Beng–*Akashmone.*

Habit—A straight, quick-growing tree, up to 16 m, with angular branches. *Bark*—white, smooth, somewhat fissured. *Leaf*—pinnate, rachis modified into a phyllode. *Flower*—white to rich-yellow, fragrant, in axillary, 3.75–6.25 cm long spikes. *Fruit*—hard, brown pod, coiled at maturity; collected during December–March, dried for 5–9 days under the sun to open. *Seed*—30,800–42,800/kg; germination 30–65 days, 30–70%; retains viability up to 2 years; can be stored at room temperature; may be treated with cold water for 24–48 hrs or hot water for 12 hrs or conc. sulphuric acid for 20–30 min or scarified.

Distribution and Ecology—Native to Australia, introduced into arid and semi-arid regions of Bihar, West Bengal, Orissa, Andhra Pradesh and Maharashtra; also in Uttar Pradesh and Karnataka, and in North-eastern hill-region. Suitable from sealevel to 1000 m. A tree found in mixed xeromphic thorny forests and grows on several types of soils.

CULTIVATION/REGENERATION

Natural Regeneration—Occurs in the open under the parent-tree.

Artificial Regeneration—Can be sown during July–August directly in hoed-up lines at 1m spacing and thinned after 2 years. Also, the seedlings can be transplanted; soaked seed is planted in polythene-bags for transplanting; kerosene spray protects the seeds from insects; 15–30 cm high plant is transplanted during June–July; also raised from stumps 1m apart; early weeding is essential; later it outgrows others. It coppices well. Application of NPK helps the growth. Yield of wood 4 tonnes/ha in West Bengal. Close spacing yields firewood in third year.

UTILIZATION

Reclamation—Useful for arid, semi-arid, skeletal, saline, alkaline, sodic, poor stony soils, ravines, clayey-brown, laterite soils, and coastal sand-dunes as a sand-binder; suitable for grassy blanks and hillsides; a good substitute for *Eucalyptus*; also a good shade- and avenue-tree. Reclaims soil with prolific litter and fixes nitrogen. Recommended for social forestry. Grows on papermill sludge (*p*H 9.5) and on coalmine and bauxite spoils. Improves the porosity and productivity of the soil in and around fields; and also improves the quality of water in the neighbouring wells. Useful as lac-host.

Timber—Furniture; pulp for paper.

Fuel—Reasonably good firewood (4800–4900 kcal/kg).

Others—*Bark:* Yields tannins (12.16%); can be substituted for that of *A. nilotica* ssp. *indica* for producing quality leather. *Flower:* Useful in cosmetic industry. *Seed:* Yields an edible, fatty oil (26%).

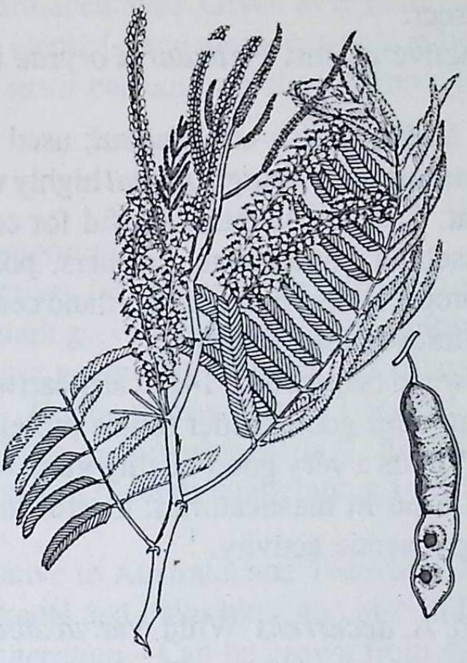
A. catechu Willd. THE CUTCH-TREE

Beng–*Khayar;* Guj–*Kherio-baval;* Hindi & Punjab–*Khair;* Kan & Tel–*Kaachu;* Mal–*Kadevi;* Oriya–*Khoiru;* Sans–*Khadiram;* Tam–*Karngalli.*

Assam–*Khoria.*

Habit—A prickly tree, with a cylindrical stem, generally 3 m/0.9 m, rarely reaching 15 m/2 m. *Bark*—dark greyish-brown, exfoliating in long and narrow strips, 1.27 cm thick. *Leaf*—pinnate, with a pair of recurved prickles at the base of rachis. *Flower*—pale yellow, in cylindrical spikes; June–August. *Fruit*—glabrous, flat, oblong pod, readily dehisces; disperses seed through wind and water; September–January. *Seed*—38,870–40,000/kg; January–March; germination 30 days, 60–100%; readily germinates with moderate rain but viable for 12 months; can be stored at room temperature; sometimes may need scarification or hot-water treatment.

Distribution and Ecology—Common throughout the sub-Himalayan tract from Punjab to Assam, up to 1200 m; also common in peninsular India,



Acacia catechu

particularly in drier parts; in Madhya Pradesh in open grasslands and teak forests; in dry, open, thorny forests in Maharashtra and Gujarat. Suited to low-rainfall areas and subtropical lower temperatures. Grows best on porous alluvium and on loam or gravel with varying proportions of clay and sand and acid soils; also grows on several degraded soils.

CULTIVATION/REGENERATION

Natural Regeneration—Germinates readily with rains and the seedlings grow fast if protected from weeds and animals.

Artificial Regeneration—Can be sown directly during July, particularly for line-sowing for plantations; loose soil free from weeds and abundant light help the crop; thinning and irrigation stimulate the growth. Seedlings can be transplanted and stumps also can be employed.

A root-parasite, a few beetles, porcupines and angiospermic parasites attack the plant.

UTILIZATION

Reclamation—Recommended for arid, semi-arid, black soils, skeletal soils, saline-alkaline and sodic soils, rocky and semi-rocky areas, gullies and ravines, mine wastelands, and other eroded lands; planted for checking erosion of various types of soils and helps in fixing nitrogen; also conserves water; recommended for agro- and social forestry.

A host for lac-insect.

Plant-extract is active against *Piricularia oryzae* and *Colletotrichum falcatum.*

Timber—Yields *katha*, CUTCH and *khursal*; used in betel-quid (pan) and in medicine, in printing and dyeing; *khursal* highly valuable for treating cough and sore-throat. Contains tannins. Useful for constructional work, agricultural and household implements, crushers, posts, handles, boats, small articles, mineprops, etc.; suitable for portland cement-bonded wood-wool boards, and cellulose-based industries.

Fuel—Good firewood (sapwood, 5142 kcal; heartwood, 5244 kcal/kg).

Fodder—Leaf provides good fodder (crude protein, 12%).

Others—Bark: Yields a very good-quality gum, regarded as a substitute for gum arabic; used in masticatories. Useful in dental care. *Seed:* Extract shows hypoglycaemic activity.

A. dealbata Link syn. A. *decurrens* Willd. var. *dealbata* (Link) F. Muell. ex Maiden SILVER-WATTLE

Habit—An evergreen tree, up to 33 m/1.2 m or more. *Bark*—somewhat silvery-grey. *Leaf*—bipinnate, 14–18 pairs of pinnae, grey. *Flower*—yellow, fragrant, profuse, in terminal-panicled, globose racemes. *Fruit*—slightly constricted, straight or curved, flattened pod, 5.0–7.5 cm long; June. *Seed*—71,000–88,000/kg; almost throughout the year; germination 30 days, 70–100%; viable for more than 2 years; may be immersed in boiling-water or scarified.

Distribution and Ecology—Native to Australia and Tasmania, introduced on the Nilgiri and Palni hills; also planted in Naini-Tal, Almora and on Shimla hills, at 1200–2400 m. Grows on the hills and in semi-arid and arid regions; moderately tolerant to salinity.

Cultivation/Regeneration—Establishes from seeds in July; also from the transplantation of seedlings during October; has extraordinary power of reproduction through rootsuckers; susceptible to frost, and suffers from snowbreak. Attacked by *Loranthus* sp.

UTILIZATION

Reclamation—Planted on the unstable soils on the hills, grassy blanks, arid and semi-arid areas and moderate saline soils. Fixes nitrogen.

Fuel—Used as firewood.

Fodder—Leaf lopped.

Others—Bark: Yields tannins (9–17%; sometimes up to 25%). Also yields a high-quality gum, resembling gum arabic, but has tannins; astringent. Suitable for pharmaceuticals. Given as remedy in bronchial diseases and as an antidote to alcohol- and ammonia-poisoning. *Flower:* Used in the preparation of *Mimosa* perfume which resembles YLANG-YLANG, but is slightly coarser.

A. decurrens Willd. COMMON WATTLE, GREEN WATTLE

Tam–*Semai velampattai.*

Habit—An evergreen, fast-growing, frost-hardy tree, 8–12 m. *Bark*—olive-green, turning dark grey on old trees. *Leaf*—bipinnate, 4–10 pairs of pinnae. *Flower*—bright yellow, in terminal or axillary, globose heads of compound racemes. *Fruit*—narrow, flat, 11-seeded pod. *Seed* —black 80,357–111,000/kg; May; germination 30 days, 70–100%; viable for more than 2 years; can be stored at room temperature; may be immersed in hot water or scarified.

Distribution—Native to Australia and Tasmania, introduced and cultivated on the Kodaikanal and Palni hills, and also in Uttar Pradesh.

Cultivation/Regeneration—Can be grown from direct sowing during June–July. Can also be transplanted; also rootsuckers can be employed.

UTILIZATION

Reclamation—Planted in tea-gardens for green manure and to serve as windbreaks; also suitable to check coalash erosion by wind, and for grassy blanks. Fixes nitrogen.

Timber—Fairly good raw material for pulp. Tender branches used for reinforcing mud-walls.

Fuel—Good-quality firewood.

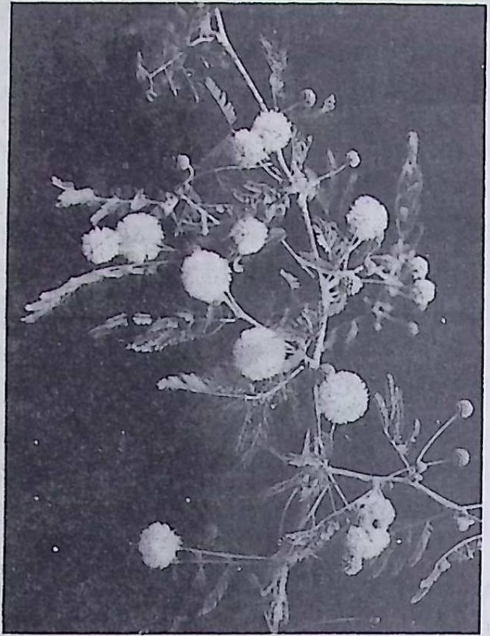
Others—Bark: Yields tannins (30–40%), but not popular due to red colour. Astringent; decoction given in severe dysentery. Possesses antitumeric activity due to polymeric flavonols. *Seed:* Yields a pale-brown, fatty oil (9.41%).

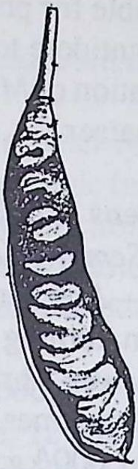
A. farnesiana Willd. THE CASSIE-FLOWER

Beng–*Gayababul;* Guj–*Gandhelobabul;* Hindi & Punjab–*Pissibabul;* Kan–*Kasturijali;* Mal–*Arivelam;* Mar–*Kankar;* Oriya–*Kapur;* Tam–*Kadivel;* Tel–*Kasturitumma.*

Assam–*Tarwakadam;* Bihar–*Grabur;* Madhya Pradesh–*Gandhiobabul.*

Habit—A spiny bush or small tree, 4.5 m. *Leaf*—bipinnate, with stipular spines. *Flower*—bright yellow, fragrant, in axillary heads; starts at 3–4 years; November–March; mature tree yields 1 kg/season. *Fruit*—dull-brown pod, 5.0–7.5 cm long. *Seed*—9000–16,000/kg; almost throughout





A. farnesiana

the year; germination 30 days, 60–100%; viable up to 2 years; can be stored at room temperature; may need immersion in boiling-water or soaking in conc. sulphuric acid for 45min or scarification.

Distribution and Ecology—Native to tropical America, naturalized in India, up to 1250m or above, having a rainfall of 250–1250 mm. Often occurs gregariously on loose, sandy soils of riverbeds or on pure sands or alkaline and saline soils almost all over India. Withstands normal frost.

Cultivation/Regeneration—Seed directly sown in May; transplanting can also be done.

UTILIZATION

Reclamation—Recommended for arid and semi-arid soils, saline, alkaline and sodic soils; makes good fence. An important nitrogen-fixing plant.

Timber—Tentpegs, shipknees.

Fuel—Used as firewood.

Others—*Bark:* Used for tanning; acrid and astringent. *Gum:* Suitable for confectionery, often marketed with other acacia gums. *Leaf:* Sour; used as a substitute for tamarind; prescribed in gonorrhoea. *Flower:* Yields CASSIE perfume; fatty residue is made into brilliantine and other cosmetics. *Fruit:* Yields tannins (23%). *Seed:* Yields an oil (2%).

A. jacquemontii Benth.

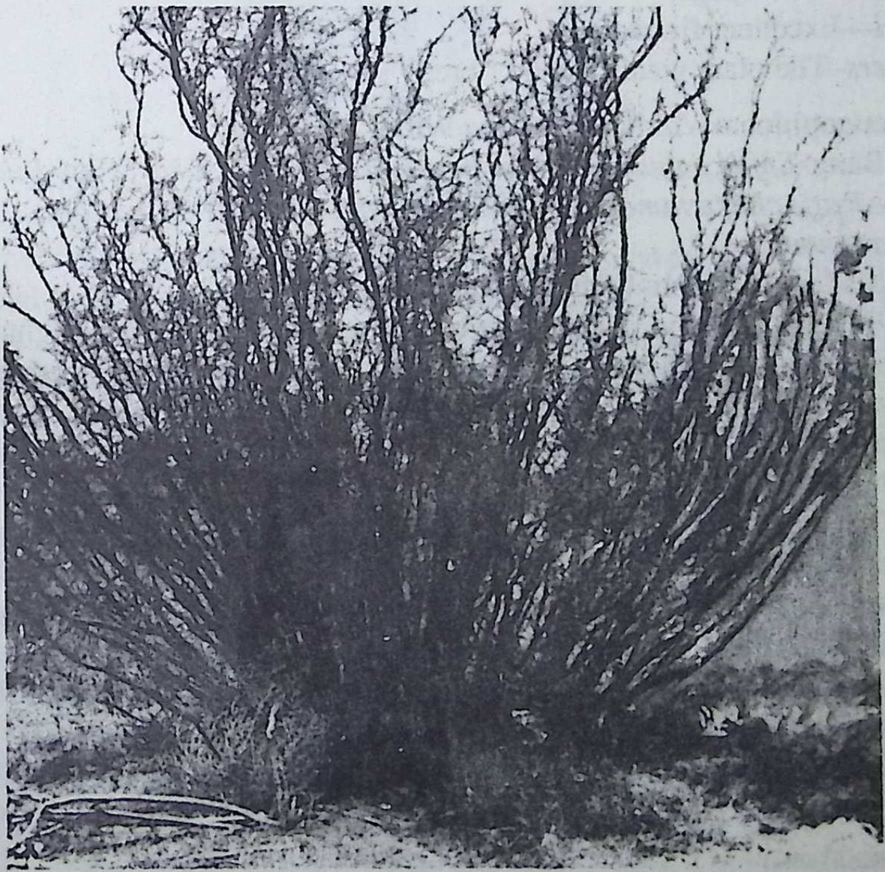
Guj–*Ratabauli;* Punjab–*Batnul;* Rajasthan–*Bubanvali.*

Habit—A spiny bush or shrub, with stiff, smooth, brown branches, 1.5–2.5 m. *Leaf*—bipinnate, 2.5–5.0 cm long, ivory-white, with stipular spines, 2–4 pairs of pinnae: leaflets 5–10 pairs, linear-oblong, glabrous. *Flower*—yellow, sweet-scented, in axillary, globose heads; December–February. *Fruit*—ovate-oblong, flat, straight, glabrous, non-pulpy pod, 3–6 cm × 1.2–1.5 cm; March–May. *Seed*—compressed, 5–8.

Distribution and Ecology—Chiefly found in Punjab, Rajasthan and Gujarat. Gregarious in Rajasthan, commonly found in the lower piedmont plains, older alluvium with hammocky and undulating topography on low sand-dunes, with a rainfall of 100–300 mm; also grows on mineral soils.

UTILIZATION

Reclamation—A great sand-binder, recommended for the soils in Rajasthan including sand-dunes and other arid-zone soils. May be grown on mine-spoils. Good hedge and windbreak; dried thorny branches also used as hedges.



A. jacquemontii

Fuel—Good firewood; charcoal is made out of it.

Fodder—Shoot and leaf lopped.

Others—*Bark:* Used for tanning leather brown or black; yields inferior-quality gum, used in times of scarcity.

A. latronum Willd.

Hindi–*Bhes;* Kan–*Donnamullinajolli;* Mar–*Devbabhal;* Tam–*Karodei;* Tel–*Paakeetumma.*

Habit—A gregarious spiny shrub, up to 2 m. *Leaf*—bipinnate. *Flower*—in pedunculate spikes. *Fruit*—oblong, thin, flat pod.

Distribution and Ecology—Common in the drier parts of the Deccan and other parts of South India. Often grows on bare gravelly soils both on flat ground and hillslopes.

UTILIZATION

Reclamation—Useful in preventing soil-erosion on the hillslopes and gravelly soils.

Timber—Tentpegs.

Fuel—Excellent firewood.

Others–The plant yields a good fibre.

A. leucophloea Willd. syn. *A alba* Willd.

Beng–*Safed babul;* Guj–*Haribaval;* Hindi–*Safed kikar;* Kan–*Bilijali;* Mal–*Pattacharayamaram;* Mar–*Hewar;* Tam–*Velvayalam;* Tel–*Tellatumma.*

Madhya Pradesh–*Vilayatibabul;* Rajasthan–*Arunj.*

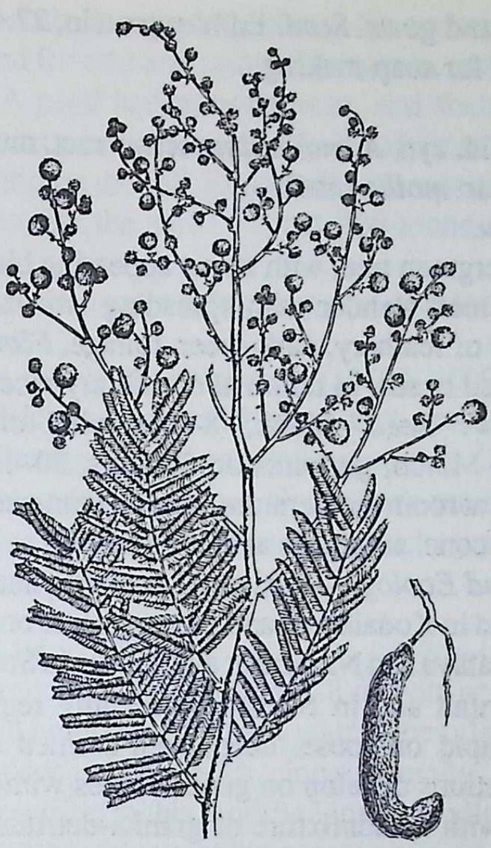
Habit—A spiny, deciduous tree, up to 3 m/0.9 m. *Bark*—light yellowish-grey to nearly white, red inside, smooth, exfoliating in irregular flakes. *Leaf*—bipinnate, with spines. *Flower*—yellow, in heads, arranged in terminal panicles, 30 cm long. *Fruit*—black, narrow pod, 10–20 cm long. *Seed*—10–20 in a pod.

Distribution and Ecology—Found in the dry forests of India, and in areas with 250–1525 mm rainfall. Smaller in very dry localities with a crooked and gnarled stem. Found in forests of deep and sand-deposits, in flat alluvial plains in arid zone in Rajasthan and Gujarat with calcareous deep loam-sand or sandy loam, lower piedmont, saline blanks and saline-alkaline land; can grow on mineral soils.

Cultivation/Regeneration—Establishes from seeds; seedlings can also be transplanted.

UTILIZATION

Reclamation—Very useful for the arid and saline blanks and saline-



A. leucophloea

alkaline soils, alluvial plains, mineral soils, gullies and ravines, sodic soils, skeletal soils, loam-sand and sandy loam and in areas with 250–400 mm rainfall. Conserves moisture, and fixes nitrogen. Useful as hedges, windbreaks and on fieldbunds; grown in agroforestry and reported to increase the yield of *jowar;* also grown with horsegram. Recommended for social forestry.

Yields a large biomass up to 146qt/ha.

Timber—Agricultural implements, oilmills, carts and cartwheels, turnery work. Heartwood extract antibacterial.

Fuel—Used as firewood (sapwood, 4899 kcal; heartwood, 4886 kcal/kg).

Fodder—Leaf lopped, except during summer.

Others—Bark: Powdered bark and seed is mixed with flour in times of scarcity. Astringent and used in bronchitis and biliousness. Yields tannins (9.22%); a good substitute for wattle, *Cassia auriculata* and *C. fistula.* Yields a fibre, used for coarse cordage and fishing-nets. Used for clarifying and flavouring. Yields a gum; used as demulcent and for emulsifying. *Fruit:*

Relished by sheep and goats. *Seed:* Edible (protein, 27.4%); yields a fatty oil (12.6%), useful for soap-making.

A. mearnsii de Wild. syn. *A. mollissima* sensu auct. mult., non Willd.; *A. decurrens* Willd. var. *mollis* Lindl. BLACK WATTLE

Tam–*Chavukku.*

Habit—An evergreen tree, with stems appearing black, up to 25 m; in plantation grows erect; slender with spreading crown. *Leaf*—bipinnate, pinnae 15–20 pairs of feathery, dark-green foliage. *Flower*—pale yellow, in simple or panicled heads, in terminal or axillary racemes. *Fruit*—dark, pubescent, narrow. *Seed*—black, 8–10, with club-shaped arils; 65,000–95,000/kg; March; germination 30 days, 30–100%; viable for 2 years; can be stored at room temperature; may be immersed in boiling-water for 12–24 hrs or in conc. sulphuric acid, or stratified.

Distribution and Ecology—Native to Australia and Tasmania, introduced and cultivated in Kodaikanal and on large scale on the Nilgiri and the Palni hills, in Meghalaya and Nagaland; also grown in South Rajasthan with 500–2000 mm rainfall and in North-eastern hilly regions. Grows on a variety of soils; rapid on loose, deep, well-drained soils in moderate climate; best plantations develop on gentle slopes with deep-red, dolerite soils, particularly with an admixture of granite-detritus. Also on skeletal soils, hilly tract with higher rainfall in Rajasthan.

Silvicultural Characters —Up to 5 years the seedlings are frost-tender. Weeding without disturbing the soil stimulates growth. Does not coppice well and regenerates under *Eucalyptus globulus*.

Recommended for mixed plantations.

CULTIVATION/REGENERATION

Natural Regeneration—Through seeds and rootsuckers. Protection from frost with shelterbelts encourages regeneration.

Artificial Regeneration—Direct sowings by broadcasting the treated seed is good. Two-month-old seedlings are pricked and planted in small polythene-bags for two months. After 3 or 4 months, 20–30 cm tall seedlings can be transplanted. Responds mainly to super-phosphate (250kg/ha) and secondarily to lime (11.5tonnes/ha) and potash (125kg/ha) according to the soil; fertilizers make the seedlings frost-resistant. Growth is stout at very high temperature. Stem-canker, caused by *Dothiorella pithyophylla,* causes gummosis leading to death; bark becomes useless.

UTILIZATION

Reclamation—Grown on hillslopes to stabilize poor and sloping soils from erosion; better with *Eucalyptus globulus* for conservation of soil and water. Recommended for arid and semi-arid regions, and for skeletal soils and grassy blanks. A good hedge, windbreak, and shelterbelt. Grown in agroforestry; fixes nitrogen very efficiently. Leaf-litter of 1600–2000kg/ha/year drops and enriches the soil. Reported that crops grown after or with black wattle give double the yield. About 200-tonne wood/ ha can be obtained.

Timber—Fibrous raw material for pulp, and also for various cellulose derivatives like rayon.

Fuel—Excellent firewood and charcoal (3500–4000 kcal/kg).

Others—Bark: Rich in tannins (35%); extract produces a well-tanned leather of medium firmness, good wearing properties. Good resistance to water with a fine grain and pale colour. Spent-bark can be used for straw-board and in activated carbon industry. A satisfactory adhesive from the tannins is prepared for plywood veneers.

A. melanoxylon R. Br. AUSTRALIAN BLACKWOOD

Habit—An evergreen tree, up to 36 m/1.8 m, with erect bole up to 25 m and dense crown, and branchlets angular; young ones glabrous or minutely pubescent. *Bark*—dark grey, rough, longitudinally and transversely furrowed. *Leaf*—bipinnate; rachis modified into a phyllode; leaflets found only when young; phyllode falcate-oblong or almost lanceolate, 7.5–10.0 cm long. *Flower*—yellow, in globose heads, in axillary racemes, with 50 or more flowers. *Fruit*—linear, flat pod, often curved in a circle; July–November. *Seed*—small, nearly orbicular with a pale-red funicle; 55,000–94,000/kg; almost throughout the year, germination 30 days, 30–100%; viable for 2 years; can be stored at room temperature; may need hot-water treatment or scarification.

Distribution and Ecology—Native to South Australia and Tasmania, introduced and naturalized on the Nilgiri hills and grown on the Kodaikanal and Palni hills. Typical on rich soils and on lands unsuited for grasses.

Cultivation/Regeneration—Can directly be sown; seedlings also can be transplanted.

UTILIZATION

Reclamation—Recommended for denuded hillslopes for stabilizing, and grassy blanks, centres of livestock farming where the land is unsuitable for intensive cultivation of grasses and legumes. Useful as a windbreak, shade-tree and as an ornament. Suitable for growing on slime-dumps of mines.

A good nitrogen-fixer.

Timber—Highly valued for furniture, railway-coaches, cabinet-work, bent-work for boats, casks and tennis-racquets, and for pulp.

Fuel—Used as firewood on the Nilgiris.

Fodder—Leaf excellent and can be lopped twice a year; can supply 50–80% dry matter for livestock.

Others—Bark: Yields tannins (7.04%); exudes a gum. *Seed:* Reported to have a lowering effect on total liver- and blood-cholesterol levels in rats (crude protein, 39.7%).

A. mellifera (Vahl) Benth.

Habit—A fast-growing, bushy, deciduous tree, 8–10 m, with grey stem, having black, curved prickles. *Root*—well-spreading, with bacterial nodules. *Leaf*—pinnate: leaflets generally in 3 pairs, rarely 2, obovate, oblong. *Flower*—white, mildly fragrant, with nectar, in cylindrical, elongated racemes; starts after 3 years and twice a year. *Fruit*—pale-brown, flat, 2–8-seeded pod; twice a year. *Seed*—orbicular to lenticular; 20,000/kg; germination 30–100%; viable for a long period; pretreatment with 45% sulphuric acid or hot water hastens germination.

Distribution and Ecology—Native to Ethiopia, introduced into India in Coimbatore and Dehra Dun, showing very promising growth. Forms gregarious impenetrable, thorny thickets in dry scrub and deciduous bush-land.

CULTIVATION/REGENERATION

Natural Regeneration—Profuse under mature trees noticed at Coimbatore.

Artificial Regeneration—Raised from pretreated seeds in nurserybeds during the rainy season. Two seedlings are planted at 5 m×5 m. Growth is very fast; gains 45 cm girth at breast-height in 7 years.

UTILIZATION

Reclamation—A drought-resistant plant, showing good promise for afforestation and reclamation in the arid and semi-arid and sandy areas. Its adaptability to sandy, clay and gravelly soil, drought-resistance and profuse natural regeneration makes it a multiutility plant. Fixes nitrogen.

Timber—Building-poles, fencing; suitable for craftpulp and paper-making.

Fuel—Used as firewood and charcoal.

Fodder—Tender leaf lopped.

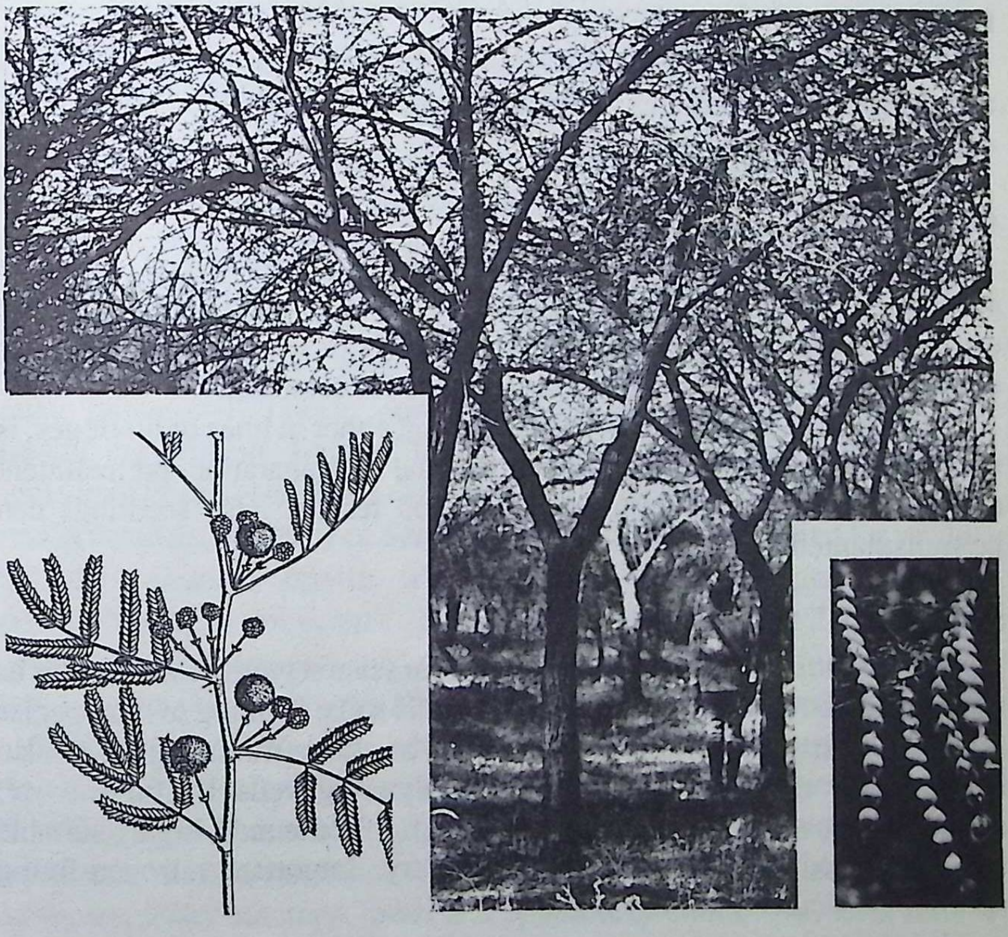
Others—Flower: Yields nectar.

A. nilotica Delile ssp. **indica** (Benth.) Brenan syn. *A. arabica* Willd. var. *indica* Benth. INDIAN GUM-ARABIC TREE, BLACK BABOOL

Beng, Hindi, Punjab & Madhya Pradesh–*Babul;* Guj–*Baval;* Kan–*Karijauli;* Mal–*Karivelan;* Mar–*Vedibabul;* Oriya–*Baubra;* Tam–*Karuvelamaram;* Tel–*Nallatumma.*

Bihar–*Babulo.*

Habit—An almost evergreen, fast-growing tree, with short stem and a spreading crown and feathery foliage. *Bark*—dark brown to almost black, longitudinally fissured or deeply cracked. *Leaf*—bipinnate, 2.5–5.0 m long, with spines: pinnules narrowly oblong. *Flower*—golden yellow, fragrant, in long-stalked, globose heads; generally in rainy season but may extend to December–January. *Fruit*—greyish-green, flat pod, 7.5–15.0 cm long, constricted between the circular seeds; bears from an early age; April–June: *Seed*—sheep and goats eat pods and disperse seed; 7000–11,000/kg; germination 30 days, 30–70%; can be stored at room



A. nilotica

temperature; viable for more than 2 years; sometimes needs soaking in hot water or cold water for 36–72 hrs, in conc. sulphuric acid for 5–10 min or scarification.

Distribution and Ecology—Drier parts of India. Indigenous to the plains of Andhra Pradesh and Maharashtra, up to 900 m, with a rainfall of 75–1250 mm. Essentially a tree of the plains occurring on flat or undulating ground and ravined country, rarely reaching hilly region. Thrives best on riverain alluvium subject to inundation and on black soils. Gregarious and forms either pure stands or becomes dominant, and found in meadows with grassy undergrowth, sand-dunes and waterlogged areas; found along canal-banks, roadsides, railway embankments, on wastelands, in the drier plains of Andhra Pradesh, Tamil Nadu and Karnataka; also found on the alluvial soils of North India. In Rajasthan, it is grown in the arid zone on old alluvium and shifting sand-dunes; also grown in ravines and deep and narrow gullies of Gujarat, Uttar Pradesh and Rajasthan, on eroded soils, highly alkaline soils and saline soils (*p*H 9.0), skeletal, mineral, and brackish soils.

Silvicultural Characters—A strong light-demander. Drought-resistant and frost-tender. Requires protection from the herbivores, particularly camels, sheep and goats.

CULTIVATION/REGENERATION

Natural Regeneration—For vigorous natural reproduction, complete sunlight, moisture, loose soil and absence of grasses and weeds are essential. Seed is dispersed by sheep and goats or selfsown. Germination commences early in the rains and continues for sometime.

Artificial Regeneration—Direct sowing, either in lines or on ridges, is successful for afforestation. Suitable site and its preparation, pretreatment of seed, weeding and thinning yield good results. Also seedlings can be transplanted.

UTILIZATION

Reclamation—Highly recommended for several types of wastelands as mentioned above; can also be grown on sodic soils. Planting of this species improves the porosity and productivity of the surrounding soil; also improves the quality of water in the neighbouring wells. Useful as fence, shelterbelts, avenue-tree, windbreaks, and for field-bunds; highly suitable and cultivated in agro- and social forestry. Important nitrogen-fixing species, particularly for dry regions.

It is a lac-host.

Timber—As strong as teak. Railway-sleepers, toolhandles, carts, oars, boat-building, carving and turnery, agricultural implements, tentpegs, sugarcane- and oilpresses, bedsteads, hookahstems, tops, walking-sticks, anvil-blocks, etc. Yields activated carbon, and pulp.

Fuel—A very popular firewood (sapwood, 4800 kcal; heartwood, 4950 kcal/kg); used in power-boilers; charcoal is made from it.

Fodder—Leaf is a good source for fodder (crude protein, 15%) in Rajasthan and Madhya Pradesh; also useful as green manure. Green pods also used for fodder.

Others—Bark: Ground bark mixed with *til*-seed used as food. Decoction used for gargling; also substituted for soap; astringent, demulcent, antiviral and hypoglycaemic. Yields tannins (up to 20%) and used all over India. Exudes a gum. *Fruit:* Yields tannins (whole pod, 12–19%; shell, 18–27%); unripe pod used in ink-making. Spent-bark and shell used for craft-paper. *Seed:* Eaten raw or roasted during scarcity (crude protein, 26.4%); yields an oil (6.7%).

Ssp. *cupressiformis* (J.L.Stewart) Ali & Faruque and ssp. *tomentosa* (Benth.) Brenan, introduced into India, suitable for sodic soils. The former is also useful for agroforestry, roadside-planting and shelterbelts.

A. senegal Willd. syn. *A. verek* Guillem. & Perr. THE GUM-ARABIC TREE

Guj–*Goradio babul;* Sans–*Svetakhadira.*

Bombay, Punjab & Rajasthan–*Kumta.*

Habit—A spiny, deciduous tree, sometimes branched from the base with parasol-like feathery crown, 4–13 m/30–60 cm. *Bark*—yellowish-white, pale greenish-grey, smooth, peels in flakes. *Leaf*—bipinnate with stipular spines, 6–10 pinnae, downy feathery, glaucous green. *Flower*—yellowish or whitish, fragrant in axillary, 5–10 cm long spikes, mid August–mid September. *Fruit*—straight, strap-shaped pod, *c* 7.5 cm long; ripens at the end of November. *Seed*—5–6 in a pod; pods collected for seeds when they become bronze which ensures maximum germination; 7165–33,000/kg; germination 4–30 days, 60–100%; viable for 2 years; can be stored at room temperature; may be treated for 20–30 min in conc. sulphuric acid or in cold water for 36 hrs or hot water or scarified.

Distribution and Ecology—Native to Sudan, found throughout India up to 1700 m, particularly in Haryana, Punjab, Gujarat and on the dry, rocky hills of Rajasthan. Tree suited to arid zones, grows on deep sandy soils with 25–400 mm rainfall, sandstone, rocky, gravelly refractory sites, shifting sand-dunes, rocky outcrops, lower and upper flat piedmont; mineral soils Naturally grows in sand; also in clay except in waterlogged areas.

Silvicultural Characters—Extremely hardy and drought-resistant and one of the cash-crops of the deserts. One or two weedings are essential in the first year. Seedlings are fire-tender and to some extent susceptible to frost. Protection is needed from browsing by goats, damage by desert-rats and also from whiteants.

CULTIVATION/ REGENERATION

Natural Regeneration—Directly takes place from seeds.

Artificial Regeneration—Treated seeds are directly planted on ridges made on moist beds, at 60 cm × 30–60 cm. Seedlings withstand transplantation even in extremely arid conditions. They attain an average height of *c* 11cm in the first season in gravelly soils, and 20 cm in sandy soils.

UTILIZATION

Reclamation—Recommended for the above-mentioned soils; also

A. senegal

suitable for alkaline soils. A thick forest can be grown to cover bare areas including the cliffs, and to control wind-erosion; can be grown as hedges and windbreak in the desert. An important plant for nitrogen-fixing. Grown in association with watermelon, millets, forage-grasses, etc. under agroforestry.

Timber—Poles and agricultural implements; young stems used for toolhandles and weaving-shuttles.

Fuel—One of the best firewoods and for charcoal (3200 kcal/kg).

Fodder—Leaf forms an important feed for camels, sheep and goats during early and dry season (crude protein, 10–15%). Fruit also given as fodder.

Others—Bark: Exudes a gum, THE TRUE GUM ARABIC; plant from sandy areas and semi-rocky areas yield more gum than rocky-areas. Best period for tapping is May–June. Commercially used in foods and beverages, pharmaceuticals, confectionery and in several other industries as emulsifier and binder. Demulcent, emollient and given in inflammed surfaces. Used in hairsets and as suspending agent. *Root:* Used in dysentery, gonorrhoea and nodular leprosy. Of young trees used as toolhandles and weaving-shuttles. Rootbark furnishes a fibre, used for fishing-nets. and ropes. *Seed:* Dried and preserved for human consumption.

A. tortilis Hayne syn. *A. spirocarpa* Hochst. ex A. Rich. THE UMBRELLA-THORN TREE

Habit—A highly ornamental, fast-growing tree, 4–15 m, with a flat parasol-type crown, having straight and white thorns and small and brownish hooks; sometimes with several trunks that spray upwards and outwards supporting a flat-topped umbrella-like and feathery foliage; reduced to a small shrub of 1m under extremely arid conditions. *Root*—taproot deep and lateral roots very long. *Leaf*—pinnate, 1.25–3.75 cm long, with 4–10 pairs of small leaflets. *Flower*—white to cream, fragrant, in heads. *Fruit*—yellow-brown, spirally twisted pod, slightly constricted between seeds; November–February; 4.5–6.0 kg/tree/year, with 2.0–2.06 kg seed. *Seed*—12,000–16,000/kg; available almost throughout the year; germination 60 days, 40–60%; viable for 2 years; can be stored at room temperature; needs dipping in hot water or soaking in cold water for 12 hrs or in conc. sulphuric acid for 30 min or stratifying.

Distribution and Ecology—Native to Israel, introduced into India and extensively grown in Haryana, Rajasthan, Gujarat, Maharashtra, Andhra Pradesh, Tamil Nadu and Karnataka. Well-adapted to arid region on deep, loose, sandy soils, shallow sandy loam and alluvial, sandstone, rocky,

A. tortilis

refractory sites, shifting sand-dunes, black soils, skeletal soils and highly saline and alkaline soils; grows best in low lands. Growing exceedingly well on the sand-dunes of Ramanathapuram in Tamil Nadu and on the black soils of Maharashtra besides the soils of Rajasthan.

Silvicultural Characters—A fast-growing tree, lopping of which enhances the performance. Very highly drought-resistant and frost-hardy. Needs protection from grazing. Tolerates temperatures from 0 to 50°C.

CULTIVATION/REGENERATION

Artificial Regeneration—Sowing or transplanting should be done at 5 m × 5 m, with the onset of monsoon. In shallow soils, the spacing should be wider for proper development of lateral roots. Seedlings should be weeded.

UTILIZATION

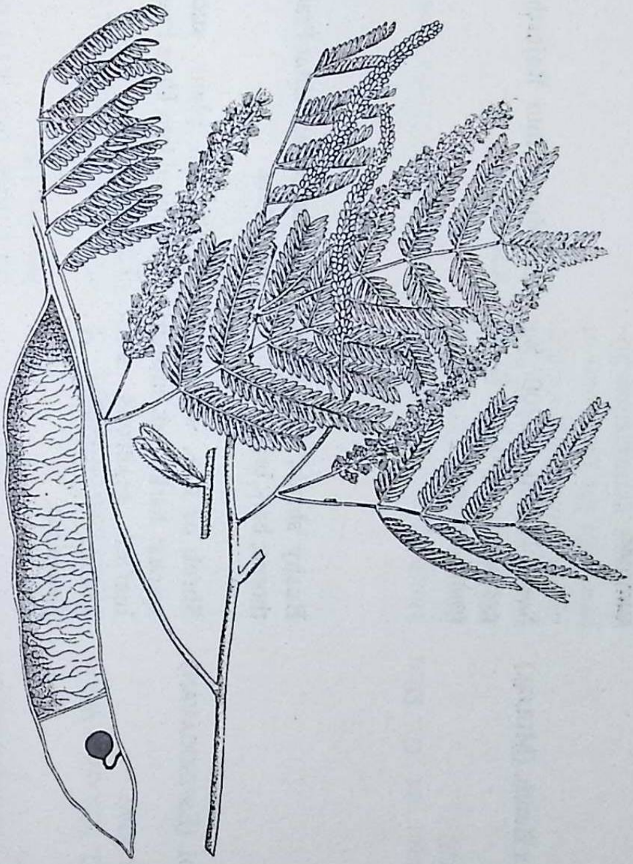
Reclamation—Best among the *Acacia* spp for reclamation and afforestation. Excellent for stabilization of sand in arid zones and performs excellently well on different wastelands, such as saline, deep sandy soils, sandstone, rocky, semi-rocky, gravelly, shallow alluvial and shallow soils overlapping hard calcareous pans. In Rajasthan, 800 ha of sand-dunes were stabilized; flat crown provides shade almost round the year in desert and produces very large biomass. Under agroforestry, it can be combined with *Sorghum* or any other millet. Fixes nitrogen better than *Prosopis chilensis*.

Timber—Fenceposts, agricultural implements.

Fuel—Potential source of fuel and charcoal (4301–4400 kcal/kg) and compares favourably with *Prosopis chilensis*, *P. cineraria* and *A. nilotica* ssp. *indica*.

Fodder—Leaf (crude protein, 15%) and pod (crude protein, 18%) are given as fodder to livestock and other herbivores.

Others—Bark: Rich source of tannins; exudes a gum .



A. ferruginea

(1)

(2)

(1) A. aneura (2) A. albida

SOME MORE *ACACIA* SPP SUCCESSFULLY INTRODUCED INTO INDIA FOR RECLAMATION OF WASTELANDS, AFFORESTATION, TIMBER, FUEL AND FODDER

Species/Common Name	Description	Distribution	Utilization
A. *albida* Delile (RING-APPLE)	Tree, 20 m/4.2 m or more; flower creamy white, scented; seed 20,400–40,000/kg; germination 0–30%; January, March, August. Sheds leaves in summer.	Native to savannahs and riverain basins of Africa, successfully introduced into western Himalayas, up to 1000 m; also in Haryana and Uttar Pradesh.	Very fast-growing; suitable for afforestation of arid, semi-arid tropics and alkaline soils. Fixes nitrogen. Leaf-litter available. Recommended for agroforestry. Yields timber, fuel, fodder, tannins, gum; woodash used as soap and for hide-curing.
A. *aneura* F. Muell. ex Benth. (MULGA)	Seed 74,000–95,200/ kg; germination 30–100%; all round the year.	Introduced into Rajasthan from Australia.	Very promising frost-hardy plant for afforestation in arid and semi-arid areas, particularly in Rajasthan on deep sandy soils; shallow sandy loam; alkaline soils; useful for shelterbelts. Fixes nitrogen.
A. *bonariensis* Gill.	Bushy shrub, with small thorns; bark brown.	Introduced into Uttar Pradesh from Argentina.	Successful on alkaline soils. Fixes nitrogen.
A. *cavenia* (Mol.) Mol. (ESPINOCAVAN)	Shrub or tree, with stout spines; bark dark brown; leaflets scabrous, dark green. Resembles A. *farnesiana*.	A Chilean plant, successfully introduced into Uttar Pradesh from Tunisia.	Suitable for alkaline soils and as a hedge. Fixes nitrogen.

A. constricta Benth. (*? A. spadicigera* Cham. & Schltr)	–	Introduced into Rajasthan from Arizona, USA.	Very promising for afforestation. Fixes nitrogen.
A. cyanophylla Lindl. (ORANGE WATTLE, GOLDEN WILLOW)	Tall shrub, up to 6 m.	Successfully introduced into India from Australia.	A drought-resistant shrub, suitable for arid and semi-arid, sandy soils. Very encouraging for reclaiming wastelands, particularly coastal sand-dunes; also saline and alkaline soils; tolerates salty winds and calcareous soils. Fixes nitrogen. Yields a gum used in foodstuffs.
A. cyclops A. Cunn. ex G. Don (COASTAL WATTLE)	Shrub up to 3 m; phyllode narrow-oblong; flowerhead solitary or in short racemes; fruit twisted; seed 23,000–30,000/kg; usually available for most part of the year; germination 30–100%; sometimes may be soaked in cold water for 24 hrs for better germination.	Introduced into India from Libya.	Promising for afforestation; particularly coastal deserts. Fixes nitrogen.
A. eburnea Willd. (Hindi & Punjab–*Paharikikar;* Mar–*Marmati;* Tam–*Kaledaiudaivel*)	Small, deciduous shrub or tree; flower yellow, in axillary heads; fruit 6–10-seeded, straight pod.	Throughout India.	Suitable for dry areas; often on black soils; chiefly used as fuel, especially for limeburning in kilns; timber used for tool-handles.

SOME MORE *ACACIA* SPP SUCCESSFULLY INTRODUCED INTO INDIA FOR RECLAMATION OF WASTELANDS, AFFORESTATION, TIMBER, FUEL AND FODDER

Species/Common Name	Description	Distribution	Utilization
A. erubescens Welw. ex Oliver	Small, deciduous, much-branched tree, up to 8 m/95 cm, with curved spines, and fairly dense, round crown; bark grey to yellowish, flaking; flower cream-coloured to white, scented.	Introduced into Uttar Pradesh from Africa.	Suitable for alkaline soils. Fixes nitrogen.
A. ferruginea DC. (Guj–*Kaigh;* Kan–*Banni;* Mar–*Pandhar-khair;* Tam–*Velvelam;* Tel–*Ansandra*)	Medium-sized tree, 3.6–4.2 m/1 m; leaf bipinnate; flower yellow, in dense spikes; fruit strapshaped pod, 7.5–10.0 cm long.	Gujarat, Maharashtra, Andhra Pradesh, Karnataka.	Suitable for mountain-slopes. Timber suitable for carts, wheels, posts, beams and agricultural implements. Yields a gum.
A. gerrardii Benth.	Small, deciduous, laxly branched tree, up to 10 m, with white thorns having a dark tip; bark dark grey; flower cream to white, scented.	Considered native to Africa and Australia, introduced into Uttar Pradesh.	Suitable for alkaline soils. Fixes nitrogen.
A. goetzei Harms	Thorny tree with a straight trunk; bark brown; leaf dark green, having recurved spines at leafbases.	Introduced into Uttar Pradesh.	Suitable for alkaline soils. Fixes nitrogen.

A. greggii A. Gray (CATCLAW ACACIA)	—	Introduced into Rajasthan from the USA.	Very promising for afforestation of arid, semi-arid and sandy areas and alkaline soils.
A. hockii de Wild.	—	Introduced into Rajasthan from Israel.	Promising for afforestation in Rajasthan, suitable for saline soils.
A. holosericea A.Cunn. ex G. Don	Pretty, fast-growing tree, 7 m; young shoots 3-angled; phyllodes silky; flower yellow, in slender, cylindrical spikes; seed 75,000–95,500/kg; December–March.	Introduced into Uttar Pradesh and Rajasthan from Australia.	Suitable for alkaline soils, sand-dune fixation, degraded mined sites; used as windbreaks, hedges and for ornament. Fixes nitrogen. Yields timber, good fuel (4670 kcal/kg) and charcoal (7573 kcal/kg). Yields large amount of dry phyllodes for fodder.
A. karroo Hayne syn. *A. horrida* auct., non (Linn.) Willd. (KARROO THORN)	Very fast-growing, small tree, branching well above the ground, 5–10 m, with white or grey thorns; bark dark brown or black; flower beautiful.	Native to Africa, introduced into Uttar Pradesh.	Grows on different soils, and adapted to a wide range of climatic conditions. Suitable for alkaline soils and on minespoils of arsenic. Fixes nitrogen.
A. lenticularis Buch.-Ham. (Kumaun-*Khin*)	Small tree; leaf bipinnate; flower grey, in spikes; fruit winged. Drought-resistant.	Sub-Himalayan tract from Kumaun to Sikkim.	Suitable for sodic soils. Timber suitable for carts and agricultural implements. Grown as shade-tree in tea-gardens.

SOME MORE *ACACIA* SPP SUCCESSFULLY INTRODUCED INTO INDIA FOR RECLAMATION OF WASTELANDS, AFFORESTATION, TIMBER, FUEL AND FODDER·

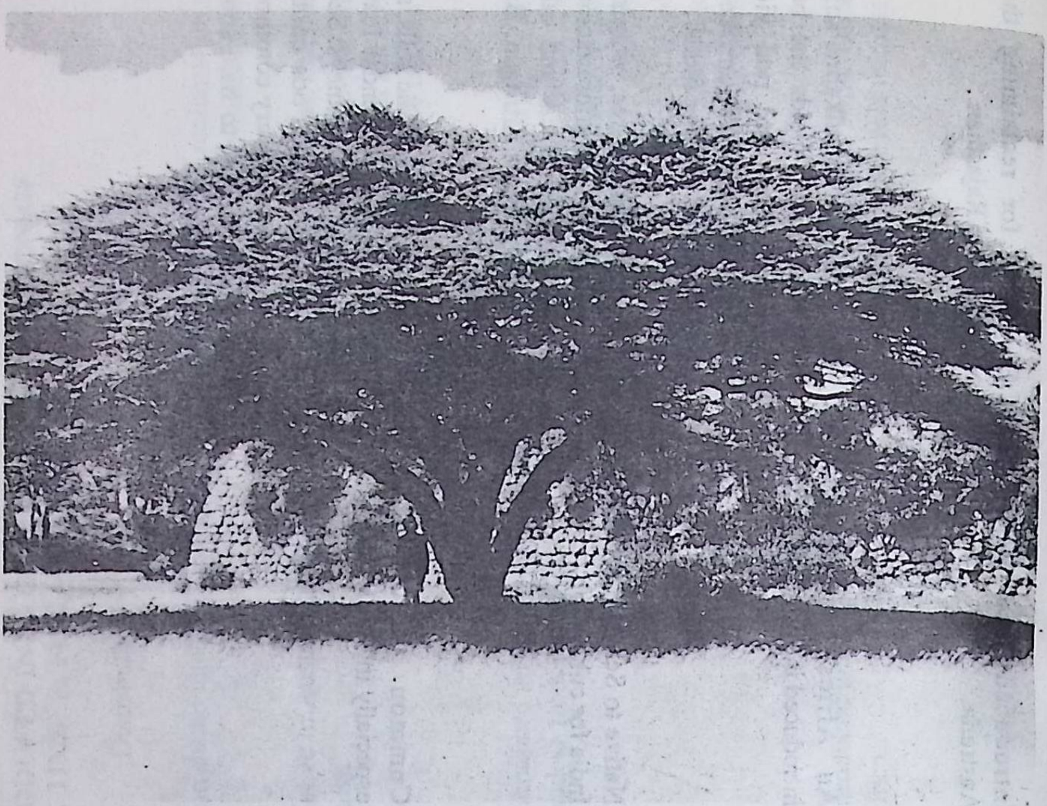
Species/Common Name	Description	Distribution	Utilization
A. *macrothyrsa* Harms	Small, much-branched tree, up to 12 m; flower golden-yellow, in great abundance, crown appearing yellow; fruit flat, reddish brown.	Native to Africa, introduced into Uttar Pradesh.	Suitable for alkaline soils. Fixes nitrogen.
A. *mangium* Willd.	–	Introduced into India in the N-E hill-region.	Recommended for growing on the slopes. Suitable for arid and semi-arid areas and hillslopes of eastern India. Fixes nitrogen. Yields good timber and fuel.
A. *modesta* Wall. (Punjab–*Phulai*)	Moderate-sized tree, 6–9 m; leaf bipinnate; flowerhead greenish; fruit 6–8-seeded pod; seed 21,179–35,300/kg; October–December; germination 30–70%; stratification or soaking in cold water needed.	Sub-Himalayan tract and in the outer Himalayan tract.	Suitable for skeletal soils, arid, semi-arid and alkaline and sodic soils. Useful in agroforestry. Timber used for crushers, agricultural implements, Persian wheels, cartwheels, etc. Very common fuel. Exudes a gum. Tender twigs used as toothbrushes.
A. *moniliformis* Griesb.	–	Kerala, Tamil Nadu, Andhra Pradesh, Karnataka.	Useful as windbreaks, hedges; recommended for agroforestry. Yields fuel.

A. nubica Benth.	–	Introduced into Rajasthan.	Suitable for reclamation of shifting sand-dunes.
A. occidentalis Rosc.	–	Orissa.	Suitable for moist to very moist areas; skeletal, laterite and hillsoils. Grown to prevent erosion. Recommended for silvipasture.
A. pennata Willd. (incl.*A. canescens* Grah.) (Hindi–*Aila;* Mal–*Kareencha;* Mar–*Shembi;* Bihar–*Maran-gakair*)	Large, thorny, climbing shrub; leaf bipinnate; flowerhead white; fruit strap-shaped pod, 15–22 cm long, 8–12-seeded pod.	Throughout India.	Recommended for sodic soils. Fixes nitrogen.
A. planifrons Wight & Arn. (Tam–*Kodaivelam;* Tel–*Godugutumma*)	Small, gregarious tree, with umbrella-like crown; leaf bipinnate; flowerhead yellow, in axillary cluster; fruit narrow, ligulate pod.	Kerala, Tamil Nadu, Andhra Pradesh, Gujarat.	Useful for reclamation of semi-arid regions. Timber useful for agricultural implements, pulp; pod used as fodder; yields tannins. Yields good fuel. Plant a host for lac-insect.
A. polyacantha Willd. syn. *A. suma* Buch.-Ham. ex Voigt; Kurz (WHITE CUTCH, PARCHMENT BARK; Beng–*Saikanta;* Kan–*Mugali;* Mar–*Kamtiya;* Tel–*Tellasandra*)	Semi-deciduous, erect spiny tree, with big, flat crown, 12 m/1.45 m; bark ash-white, turns greenish-brown or muddy brown, exfoliating in flakes; flower white, slightly fragrant; May–June, October–November; fruit strap-shaped pod, 6–8-seeded.	Native to Africa, found in West Bengal, Bihar, Uttar Pradesh, and peninsular India.	Suitable for alkaline soils and moist localities. Fixes nitrogen. A shade-tree. Timber yields cutch; also yields fuel and charcoal. Leaf and pod given as fodder. Bark and pod yields tannins. Seed possesses hypoglycaemic and anticancer activity.

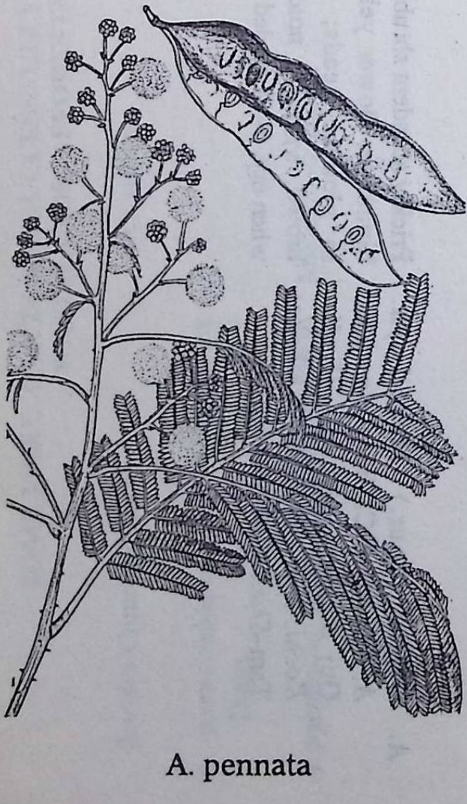
SOME MORE *ACACIA* SPP SUCCESSFULLY INTRODUCED INTO INDIA FOR RECLAMATION OF WASTELANDS, AFFORESTATION, TIMBER, FUEL AND FODDER

Species/Common Name	Description	Distribution	Utilization
A. pseudoeburnea J. R. Drumm. ex Dunn.	–	Introduced into India in Punjab.	Recommended for reclamation of saline soils and other wastelands.
A. pycnantha Benth. (GOLDEN WATTLE)	Medium-sized tree.	Native to Australia,introduced into India.	Grows on different sites; tolerates salt, useful for seashore-planting to prevent erosion. Fixes nitrogen. Bark yields tannins and exudes a gum.
A. salicina Lindl. syn. *A. ligulata* A. Cunn. ex Benth. (WILLOWTREE, COBRATREE)	Tall tree, with spreading crown and linear phyllodes; flower December–February; seed 3900–134,000/ kg; all round the year; germination 30–100%; needs immersion in hot water for 24 hrs or stratification.	Introduced into Rajasthan and Uttar Pradesh from Australia.	A frost-hardy plant, very promising for afforestation of arid, semi-arid regions, deep sandy soils and other wastelands, alkaline soils; binds soil. Planted on flood-sites, as shelterbelts and shade-tree. Fixes nitrogen. Good forage-plant.
A. schweinfurthii Brenan & Exell.	Woody climber, up to 10 m long,with bushy top, leaf dark green, with recurved prickles.	Introduced into Uttar Pradesh from Africa.	Suitable for alkaline soils. Often forms dense impenetrable thickets.

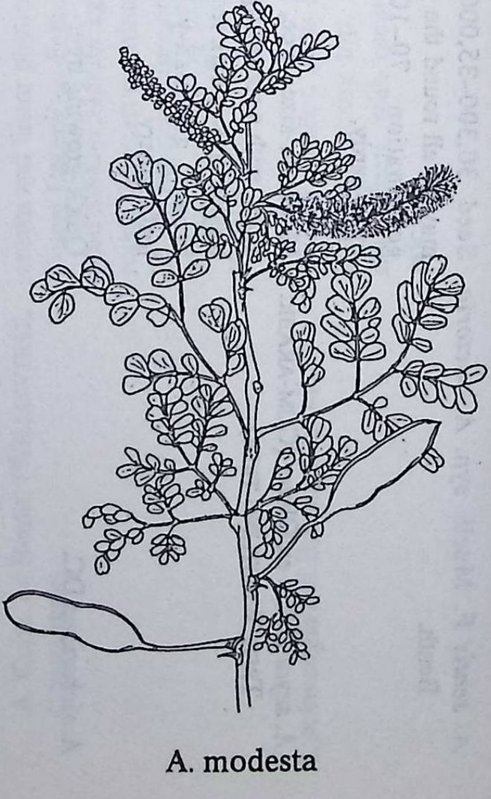
A. sentis F. Muell. syn. *A. victoria* Benth.	Seed 30,300–35,000/kg; may be all round the year; germination 70–100%. Frost-hardy.	Introduced into India from Australia.	Promising for reclaiming the wastelands in Rajasthan.
A. seyal Delile ex Oliver (GUM-ARABIC TREE, WHISTLING-TREE)	Moderate-sized tree, up to 12 m, with a spreading flat-topped crown; bark reddish-brown, greenish-yellow; leaf leathery.	An African dryland species, introduced into Uttar Pradesh.	Recommended for alkaline soils. Fixes nitrogen. Yields the best fuelwood. Bark and pod yield tannins. Bark exudes gum. Leaf, flower and pod given as fodder.
A. sieberiana DC.	Quick-growing tree.	Native to Senegal, introduced into India for cultivation.	A drought-resistant tree, promising for reclamation and afforestation of arid and sandy tracts and other wastelands. Fixes nitrogen. Bark exudes a gum.
A. sinuata (Lour.) Merrill syn. *A. concinna* DC. (Beng–*Banritha;* Guj & Mar–*Shikakai;* Hindi–*Kochi;* Kan–*Sige;* Mal–*Chikaka;* Tam–*Shikai;* Tel–*Sikaayai*)	Prickly scandent shrub; leaf bipinnate; flower yellow, in globose heads; fruit brown, wrinkled notched, when dry, 6–10-seeded pod.	Common throughout India, especially in the Deccan.	Recommended for sodic soils, and for social forestry. Tender leaves acidic and used in chutneys. Seeds roasted and eaten. Pods contain saponins; powder very commonly used as detergent to hair and to prevent dandruff.



A. planifrons



A. pennata



A. modesta

ADENANTHERA Linn. (*Mimosaceae*)

Trees; tropical Asia, Africa and Australia; 2 spp in India.

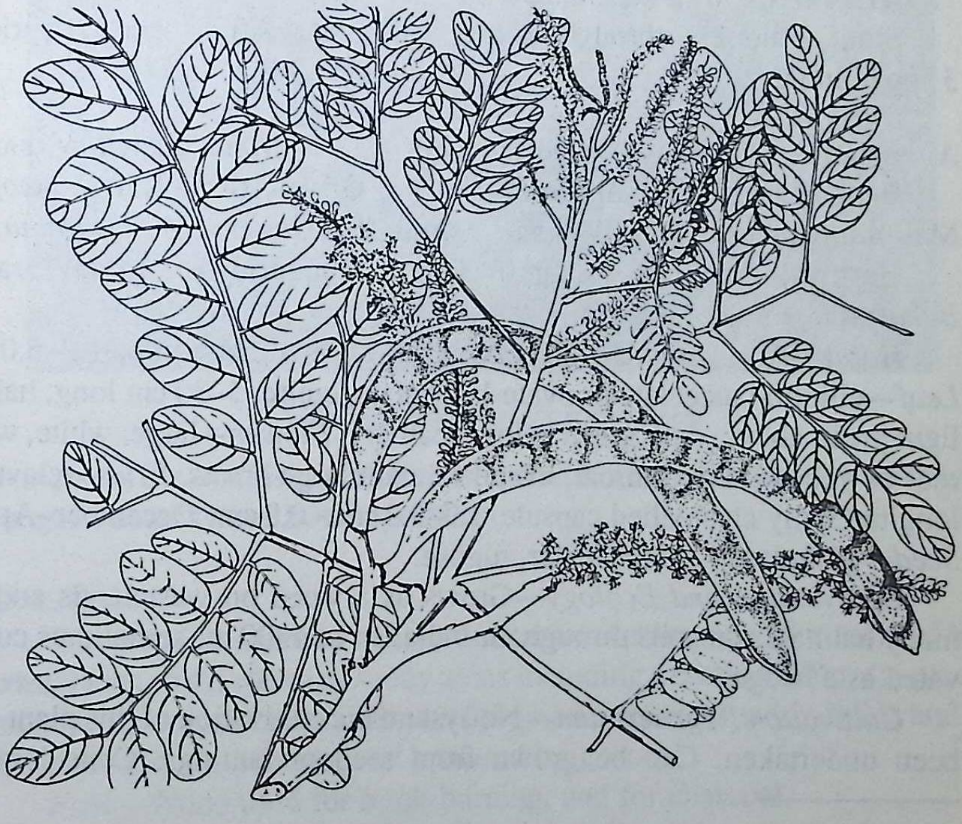
A. pavonina Linn. CORAL- OR RED-WOOD, RED-BEAD TREE

Beng–*Rakta kambal;* Guj–*Badigumehi;* Kan & Mal–*Manjadi;* Mar–*Thorligunj;* Oriya–*Giridi;* Sans–*Kunchandana;* Tam–*Anaikundumani;* Tel–*Bandiguruvenda.*

Andamans–*Recheda;* Assam–*Karliarong;* Khasi–*Dieng-thing.*

Habit—A deciduous, fast-growing, unarmed, spreading tree, 18–24 m/2.0–2.4 m. *Bark*—dark brown or greyish-brown, rough on old trees, white or brownish-white inside. *Leaf*—bipinnate, 20–30 cm long: leaflets 4–8 pairs, papery, elliptic-oblong, glabrous. *Flower*—yellow, scented, in short-peduncled, axillary racemes. *Fruit*—narrow pod, 15–20 cm long, twists while opening. *Seed*—hard, shining, scarlet, 28,000–51,000/kg; May–December; germination slow, 30–70%.

Distribution and Ecology—Sub-Himalayan tract, up to 1200 m in West Bengal, Sikkim, and Assam; also in Gujarat, Maharashtra and in South India, and the Andamans, thriving on many soils. Grows in coastal areas; planted along roadsides and avenues in South India.



Adenanthera pavonina

Cultivation/Regeneration—Propagated from seed and cutting; transplants fairly well.

UTILIZATION

Reclamation—Suitable for sandy coastal areas and the island-regions. Recommended for social forestry.

Timber—Construction; yields a red dye, substituted for true red sandalwood; contains robinetin, buterin, chalcone, ampelopsin and dihydrorobinetin.

Fuel—Excellent firewood.

Others—Bark: Used for washing hair and clothes; contains stigmasterol glucoside and a saponin. Exudes a gum known as *malatia*. *Leaf & Bark:* Decoction given in chronic rheumatism, gout and to stop haemorrhage from bowels. *Root:* Emetic; methanolic extract lowers blood-pressure in frog. *Seed:* Roasted kernels (fat, 25–30%) eaten; defatted meal rich in protein (54%). Used for suppuration, and in cholera and paralysis. Made into ornaments; powder mixed with borax and water makes a useful cement.

***ADHATODA** Mill. (*Acanthaceae*).

Stout shrubs; throughout tropical Asia, Africa and America; 3 spp in India.

A. zeylanica Medic. syn. *A. vasica* Nees MALABARNUT, VASAKA

Beng–*Basak;* Guj–*Aradusi;* Hindi & Oriya–*Arusa;* Kan–*Adusoge;* Mal–*Adalodakam;* Sans–*Vasaka;* Tam–*Adhatodai;* Tel–*Addasaramu.*

Garhwal–*Bangra;* Kashmir–*Arus;* Mundari–*Aranbida;* Oran–*Bakaspati;* Punjab–*Vasaka.*

Habit—An evergreen, gregarious, stiff, perennial shrub, 1.2–6.0 m. *Leaf*—elliptic-lanceolate or ovate-lanceolate, entire, 5–30 cm long, hairy, light green above, dark green below, leathery. *Flower*—large, white, with red- or yellow-barred throat, in spikes, with large bracts. *Fruit*—clavate, longitudinally channelled capsule, 1.9–2.2 cm × 0.8 cm; December–April. *Seed*—globular or suborbicular, rugose.

Distribution and Ecology—Grows as a weed on wastelands and in many habitats and soils throughout India, up to 1300 m; sometimes cultivated as a hedge.

Cultivation/Regeneration—No systematic cultivation of this plant has been undertaken. Can be grown from seed or cuttings. Considerable

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*Some consider it congeneric with *Justicia* Linn.

Adhatoda zeylanica on rocky areas

demand exists for this plant which is met with from wild resources. Several fungal diseases have been reported.

UTILIZATION

Reclamation—Grows everywhere and recommended for most of the wastelands, from rocky to sandy areas including denuded hilltops; recommended for social forestry. Grown for green manure in paddy-fields and in tobacco- and tea-gardens. Not browsed by goats.

Fuel—Wood used for brick-burning, and for charcoal.

Others—*Bark:* Extract exhibits antiviral activity. *Leaf:* Source of official drug VASAKA containing vasicine, vasicinone and vasakin. *Leaf, Flower & Fruit:* Extensively used in cold, cough, whooping-cough, chronic bronchitis and asthma as a sedative-expectorant, and anthelmintic. *Leaf:* Juice given in diarrhoea; paste applied on to rheumatic joints, fresh wounds, urticaria and in neuralgia; also shows respiratory stimulant, hypotensive and cardiac depressant, and selective uterine-stimulant activity; promising uterotonic, abortifacient; may be useful in jaundice; cheap and effective drug for non-ulcer dyspepsia. Used as insecticide and weedicide. Yields an essential oil (0.076%) which exhibits expectorant, rubefacient and marked antibacterial activity. *Root:* Decoction expectorant. Contains vasicine, vasicinol and tritriacontane (0.07%) and an essential oil. Extract shows antibacterial activity. *Flower:* Improves circulation of blood; used in eye-diseases. *Pollen:* May cause allergy. *Seed:* Yields a non-toxic fatty oil (25.8%).

AEGICERAS Gaertn. (*Myrsinaceae*)

Mangrove trees or shrubs; native to Australia, found in the tropics; 1sp in India.

A. corniculatum (Linn.) Blanco syn. *A. majus* Gaertn. BLACK OR GOATHORN MANGROVE

Beng–*Khalsi;* Hindi–*Halsi;* Kan–*Sule;* Mal–*Pukantal;* Mar–*Kanjala;* Oriya–*Teluni;* Tam–*Narikandam;* Tel–*Dudumara guggilamu.*

Habit—An evergreen, pretty, glabrous tree, up to 8 m. *Bark*—silver-grey, smooth. *Leaf*—obovate-obtuse, pale green with emarginate apex, long, leathery. *Flower*—white or pink, fragrant, in terminal or leaf-opposed umbells. *Fruit*—green or pinkish, horn-shaped, cylindrical follicle; germination viviparous.

Distribution and Ecology—Common in the mangrove-forests on the seacoasts and in the Andaman Islands, particularly along the tidal creeks, in estuaries, and in salty areas.

Cultivation/Regeneration—Seeds generally germinate on the tree itself and drop with radicle down, and if these fall into the mud they anchor and grow; otherwise these continue to float till they strike a substratum.

UTILIZATION

Reclamation—Builds and protects the soil and prevents erosion. Can also be planted where salinity exists at least for a part of the year.

A bee-pasture plant.

Timber—Knife-handles; buildings, huts; and stakes.

Fuel—Used as firewood.

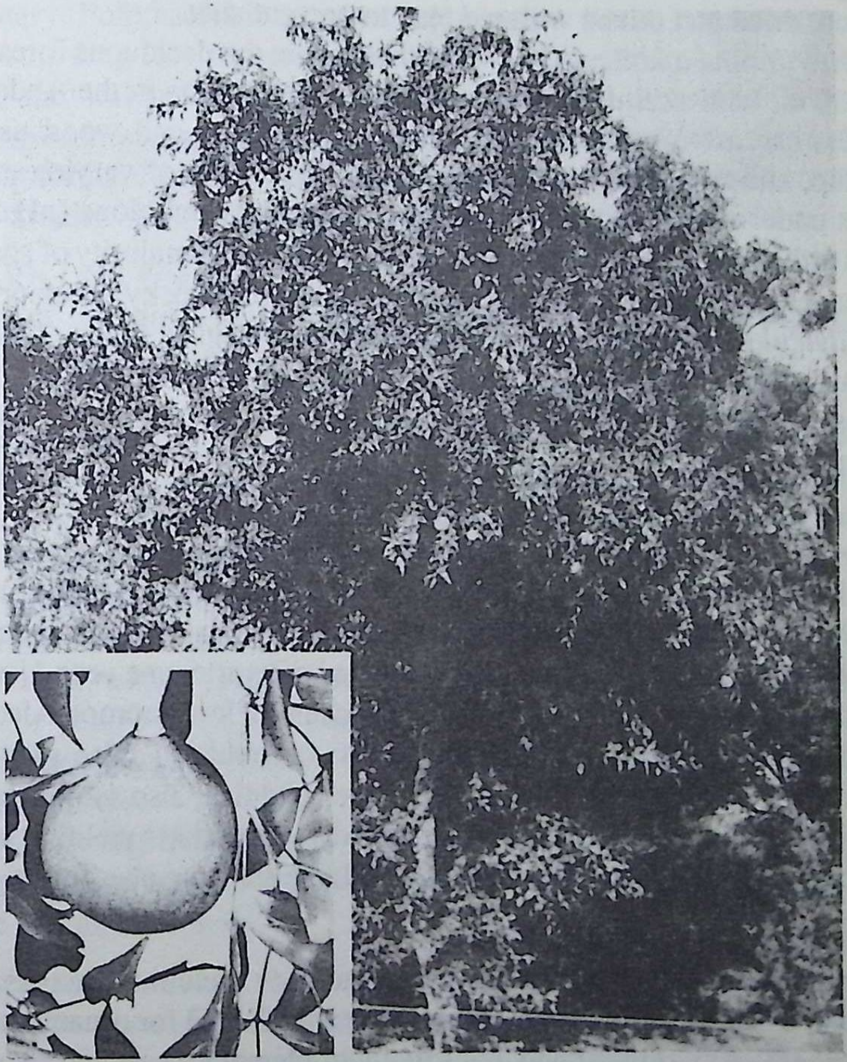
Others—Bark: Contains comparatively high percentage of tannins and compares fairly well with *Cassia auriculata. Bark & Fruit:* Considered fish-poison. *Leaf:* Contain tannins (9.5%), flavonoids, and a saponin.

AEGLE Corrêa ex Koenig (*Rutaceae*)

Thorny trees; Indo-Malaysian region; 1 sp wild in India.

A. marmelos (Linn.) Corrêa ex Roxb. BAELTREE, BENGAL QUINCE

Beng, Hindi, Mar & Assam–*Bael,* Guj–*Bili;* Kan–*Bilva;* Mal–*Koovalam, vilvam;* Oriya–*Belo;* Sans–*Bilva;* Tam–*Vilvam;* Tel–*Maaredu;* Urdu–*Bel.*



Aegle marmelos

Cachar–*Sherbili-phang;* Garo–*Belethi;* Khasi–*Soh-bel.*

Habit—A slender, aromatic tree, 6.0–7.5 m/90–120 cm. *Stem*—somewhat-fluted bole of 3.0-4.5 m, branches armed with straight, shrap, axillary, 2.5 cm long thorns. *Bark*—soft, corky, light grey or greyish-yellow, aromatic, exfoliating in irregular flakes. *Leaf*—trifoliolate, occasionally digitately five-foliolate: leaflets ovate or ovate-lanceolate, lateral sessile, terminal long-petioled. *Flower*—large, greenish-white, sweet-scented, in short, axillary panicles, more or less smooth; May–July. *Fruit*—globose, grey or yellowish, 20 cm in diam, rind woody; April–August of following year. *Seed*—numerous, oblong, compressed, embedded in sacks, with orange-coloured, sweet pulp; 5300/kg; March–May; germination 21 days, 56%; viable for 30–180 days; should be collected from trees only; washed, dried and mixed with red lead to prevent ants.

Distribution and Ecology—Wild throughout the deciduous forests, up to 1200 m; with a rainfall of 570–2000 mm; also occurs in the Andaman Islands; extensively planted near temples for leaves and wood used in worship, and for fruit. Occurs gregariously in patches of varying extent; grows under various types of climatic and edaphic conditions (*p*H 5–10) and is ordinarily found in dry localities unfavourable to majority of species; thrives well in swampy to dry soils; tolerates alkaline and rocky and poor soils.

Silvicultural Characters—Tolerates fair amount of shade. Drought- and fairly frost-hardy, and can withstand as low as –7°C; seedlings die back in frosty localities but have a good power of recovery. Produces copious rootsuckers.

CULTIVATION/REGENERATION

Artificial Regeneration—Directly sown or transplanted. Fresh seed should be sown in June or July in nursery, covered with soil and watered; growth is slow and prone to die back in frosty localities but recovers; transplanted during the first or second or third rains after one year. Usually, casualties are heavy during transplanting because of long taproot. Also, can be propagated from root-cutting and layer; desirable to raise plants by *gootee* or inarching from the selected tree; budding also is successful. Irrigation is necessary till plants become hardy. Plant starts yielding within 4–5 years. Several diseases and pests attack the tree and also fruits.

UTILIZATION

Reclamation—Recommended for wastelands including ravines; recommended in agroforestry; and for windbreaks; planted for ornament also.

Timber—Agricultural and household implements, cart and its parts, furniture-carving, catamarans, toolhandles; and pulp.

Fodder—Leaf lopped (crude protein, 15.13%).

Others—Bark: Contains tannins (11.58%). *Leaf:* Used as febrifuge, in eye-diseases and ulcers; fresh ones in dropsy and beriberi; exhibits antidiabetic action; extracts showed cardiotonic effect; and active against *Escherichia coli* and *Micrococcus pyogenes* var. *aureus;* yields an essential oil (0.6%), active against several fungi. *Root:* Ingredient of an ayurvedic preparation *Dasamoola;* decoction given in melancholia, fevers and palpitation of heart; shows antiamoebic and hypoglycaemic properties; also used as fish-poison. *Fruit:* Rind thick, stony, contains amber- or honey-coloured, viscous, sticky or glutinous, translucent, sweet and feebly aromatic pulp; a delicious cooling-drink made out of fresh fruit; tender fruits used for preserves. Astringent, digestive, stomachic and given in diarrhoea and dysentery. Pulp useful in giardiasis. Forms one of the constituents of an ayurvedic drug for dyspepsia. Clinical trials of unripe fruit showed vermifugal, antiviral and hypoglycaemic activity. Yields a water-soluble gum (2%); used in waterpaints for strength and brilliancy and for stabilization of drilling fluids. Rind contains tannins (18–20%). *Shell:* Used for making small articles. *Seed:* Yields an oil (34.4%); oil antibacterial.

AGAVE Linn. (*Agavaceae*)

Short-stemmed, woody plants; southern USA to tropical America; 6 spp introduced into India.

A. americana Linn. AMERICAN ALOE, CENTURY-PLANT

Beng–*Bilati anarash;* Guj–*Jungli kunvara;* Hindi–*Banskeora;* Kan–*Badukattalenaru;* Mal–*Panam-kattazha;* Oriya–*Birhot okumari;* Tam–*Aanaikarthaalai;* Tel–*Kittanaara.*

Punjab–*Wilayati kaitalu.*

Habit—A half-woody almost stemless, perennial. *Leaf*—erect-patent, with strong, widely patent or recurved marginal spines with longitudinal, white or yellow streaks or bands, 1.8–3.6 m × 15–20 cm. *Flower*—yellowish-green, funnel-shaped, in large panicles. *Fruit*—oblong, clavate, beaked capsule.

Distribution and Ecology—Native to America, introduced into India, naturalized and often seen as an escape throughout India. Found on sandy, saline and also red soils.

UTILIZATION

Reclamation—Can be grown on many types of waste places including sandy areas for reclamation; and to prevent erosion of bunds, railway embankments, etc. Recommended for social forestry.

Others—Leaf: Used as poultice, laxative, emmenagogue, in scurvy, as a resolvent in syphilis, scrofula and cancer; extract used as detergent. Yields an acrid, non-volatile oil which makes wall-paper and plasters resistant to whiteant. Yields a strong, durable fibre; used for ropes. *Stem:* Extract piscicidal. *Root:* Diuretic, diaphoretic, anti-syphilitic. *Flowerhead & -stalk:* Yields an alcohol; stalks used for thatching.

A. cantala Roxb. THE BOMBAY ALOE, CANTALA, MAUGEY

Punjab–*Kantala, kitki.*

Habit—A stout, scapigerous, perennial herb. *Stem*—short, woody; bulbils present. *Leaf*—in rosette, forming a crown, patent, recurved in the upper part, remotely spinescently dentate, with 1–2 cm long, upwardly hooked spines. *Flower*—greenish, in panicles.

Distribution and Ecology—Native to Mexico, introduced in many parts of the country. Grows on bunds, borders, laterite and saline soils. Also thrives well in areas with a rainfall of 100–200 cm.

Cultivation/Regeneration—Vegetative propagation through bulbils; NPK (2:2:5) improve the performance.

UTILIZATION

Reclamation—Grown as a hedge on boundaries and borders, and wastelands to check erosion.

Others—Leaf: Yields a white fibre; used for ropes, cordage, mats, twines, and nets.

A. sisalana Perr. ex Engelm. syn. *A. rigida* Mill. var. *sisalana* Engelm.

SISAL

Habit—A perennial herb. *Stem*—short, 37.5 cm thick; bulbils present. *Leaf*—in a rosette, dark green, thick, fleshy, rigid, 1–2 m×10–15 cm, generally spinous. *Flower*—yellow, in 4–6 m tall panicles.

Distribution and Ecology—Native to Mexico, introduced into India, commonly found on dry, permeable sandy loam, and saline, or red soils in low rainfall areas in Andhra Pradesh, Assam, West Bengal, Bihar, Orissa, Tamil Nadu, Karnataka and Maharashtra and on bunds, boundaries, railway embankments, etc.

Cultivation/Regeneration—Vegetatively propagated through bulbils or suckers; planted in nurserybeds; 20–30 cm high seedlings transplanted at 1.8–2.4 m apart. For good growth, organic matter needed in soil (*p*H 6–7).

UTILIZATION

Reclamation—Extremely drought-resistant; recommended for grow-

Agave sisalana

ing on wastelands and mine-spoils, such as lignite; cultivated on an estimated 10,000 ha.

Others—Leaf: Yields a fibre; used for twines, ship-cordage, webbing and sacking; substituted for Manila hemp and jute; used for paper; waste yields a hard wax; sap can be used for extraction of hecogenin and furfural; juice ecbolic and lowers blood-pressure.

A. vera-cruz Mill. ELEPHANT ALOE, GREY ALOE OF INDIA, RAILWAY-ALOE

Habit—A perennial herb, 30–45 cm. *Stem*—simple, woody; bulbils present. *Leaf*— 40–70 cm long, erect, spinescently dentate. *Flower*—in terminal panicle.

Distribution—Native to Mexico, naturalized throughout India, found along waste places, roadsides and forest-clearings.

Cultivation/Regeneration—Vegetatively propagated through bulbils.

UTILIZATION

Reclamation—Recommended for growing on wastelands, fallow-fields, roadsides, clearings, railway embankments, boundaries, minespoils, etc. for conservation of soil.

Others—Stem: Woody portion cooked with tamarind and jaggery, consumed by the poor. Stem also a rich and cheap source of polyfructosans of the type of inulin and its isomer. *Leaf:* Yields a fibre; used for ropes, cordage and mat-making; juice contains hecogenin.

A. angustifolia Haw. syn. *A. wightii* Drummond & Prain (THE DWARF ALOE; Sans–*Kantala;* Tam–*Chinna erumaikkattalai;* Tel–*Balurakkasi, kittanaara*) is a perennial herb, with stout trunk, and compact rosette of leaves and flowers in terminal panicles, introduced and naturalized in the outer Himalayas, grown in gardens and along railway-lines and recommended for waste places. Leaf yields a fibre.

A. mexicana Lam., native to Mexico, is planted in Neyveli on the lignite-spoils for reclamation.

AGROPYRON Gaertn. (*Poaceae*)

Annual or perennial grasses; temperate regions; 19 spp in India.

Some useful for forage, a few soil-binders and others medicinal.

A. repens Beauv. COUCH- OR DOGGRASS

Habit—An erect or ascending grass. *Stem*—many-jointed, long, very slender rhizome with numerous rootlets, 30–60 cm, densely tufted at base. *Leaf*—flat, glabrous or puberulous above, 2–3 mm broad. *Spikelet*—very pale, 5–6-flowered, in erect, slender, 7.5–15.0 cm spikes.

Distribution and Ecology—Native to Europe and temperate Asia, found in Kashmir, at 2000–4200 m, as a weed on agricultural lands.

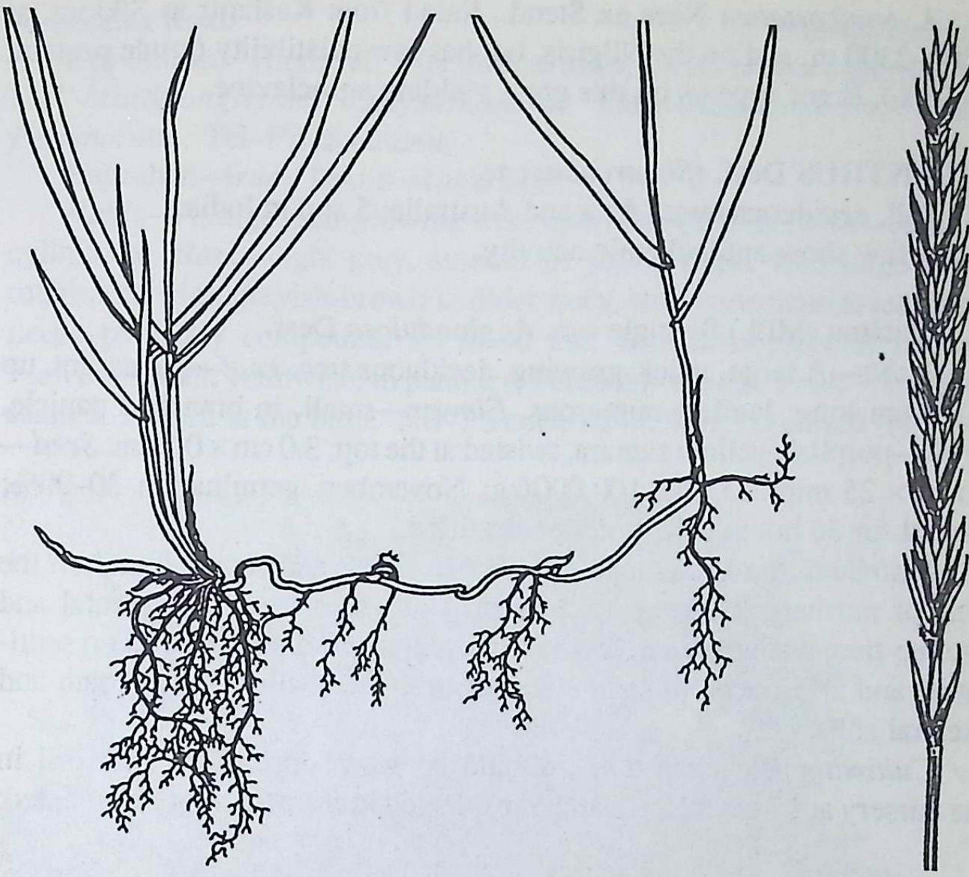
UTILIZATION

Reclamation—Recommended in controlling soil-erosion as it holds soil in embankments, terraces and steep slopes.

Ergot grows on this grass which yields several alkaloids.

Fodder—Good forage and can be used for hay, silage or pasture (crude protein, 11.2%).

Others—Rhizome: Roasted and sometimes substituted for coffee; a bread also made out of it. Diuretic, diaphoretic, demulcent, and aperient.



Agropyron repens

Also used in gout and rheumatism, and cough; causes sedation. A drink from it is demulcent in urino-genital tract. Contains triticin (5%) resembling insulin. *Root:* Juice useful in cirrhosis liver, tumours and cancer. Yields an essential oil containing agropyrene which is active against some fungi.

A. acutum Roem. & Schult. syn. *A. pungens* Reichb. is a halophytic, perennial grass, with flat or convolute leaves, introduced from Europe, found suitable for cultivation on wastelands.

A. cristatum (Linn.) Gaertn. and *A. sibiricum* Beauv., introduced into Delhi, are valuable hay- and pasture-plants, suitable for arid regions and mined sites.

A. intermedium (Host.) Beauv. syn. *A. glaucum* Roem. & Schult. (INTERMEDIATE WHEATGRASS) is a rhizomatous perennial, giving a dense cover, with 90–120 cm high stems, native to Central and Southern Europe, extending to Kashmir, at 4000 m. Easy to establish from seed (9–13 kg/ha); can be sown with lucerne (2 kg/ha) also. Useful as a soil-binder. Provides palatable pasture and excellent hay (crude protein, 6.4–9.5%).

A. semicostatum Nees ex Steud., found from Kashmir to Sikkim, at 1800–3300 m, and on the Nilgiris, but has low palatibility (crude protein, 15.05%). Ergot appears on this grass yielding agroclavine.

AILANTHUS Desf. (*Simaroubaceae*)

Tall, deciduous trees; Asia and Australia; 5 spp in India.

A few show antileukemic activity.

A. altissima (Mill.) Swingle syn. *A. glandulosa* Desf.

Habit—A large, quick-growing, deciduous tree. *Leaf*—pubescent, up to 90 cm long: leaflets numerous. *Flower*—small, in branched panicle. *Fruit*—purplish-yellow samara, twisted at the top, 3.0 cm × 0.8 cm. *Seed*—6 mm × 25 mm; 35,000–100,000/kg; November; germination 30–90%; treated for 36 hrs in cold water or stratified.

Distribution and Ecology—Native to China and Japan, found on the hills of northern India, up to 2400 m. Cultivated as an ornamental and avenue-tree; also grown in low rainfall regions in plains. Grows on semi-moist and arid tracts, in *terai* and *babhar* zone, shallow sandy-loam and skeletal soils.

Cultivation/Regeneration—Should be sown during March–April in the nursery at 15 cm × 15 cm and transplanted in July. Stumps also planted.

UTILIZATION

Reclamation—Planted on slopes and for the reclamation of the above-mentioned soils and ravines. Suitable for stabilization of eroded ravinous lands and for shelterbelts and field-boundaries in agroforestry. Being a quick-growing tree, suitable for social forestry and for cultivation on degraded wastelands, and to check air-pollution.

Reported to be good feed for silk-worms.

Timber—Construction, furniture, fancy articles; pulp for paper, rayon and fibre-boards.

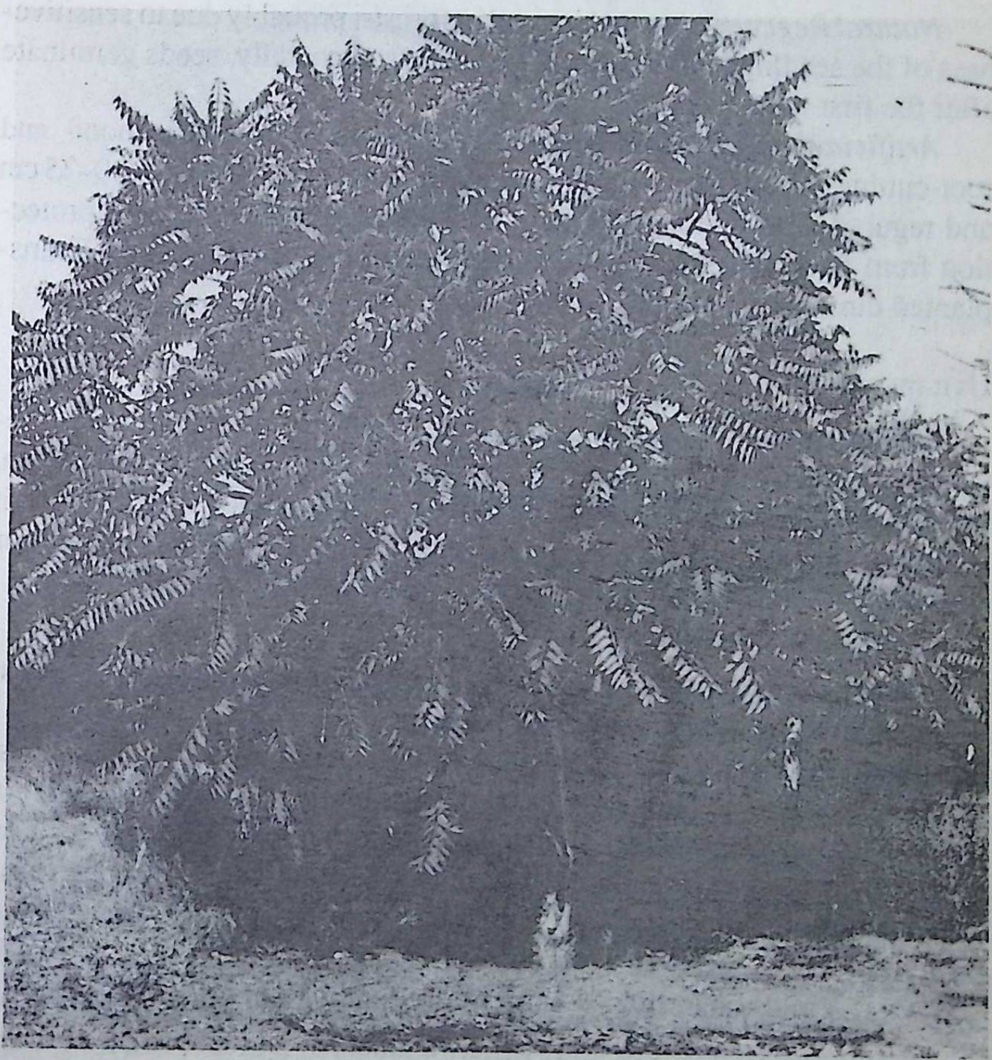
Others—*Bark:* Astringent, antispasmodic, anthelmintic and parasiticidal; powerful depressant like tobacco; fresh bark useful in diarrhoea and dysentery; yields tannins (11%). *Leaf:* Astringent, antiscabis. Yields tannins (11%) and used as adulterant to sumac. Substituted for belladonna; adulterated with or substituted for senna. *Rootbark:* Recommended in heart-ailments, epilepsy and asthma. *Flower:* Produces dermititis. Yields an essential oil. *Fruit:* Emmenagogue; used in eye-diseases. Yields a fatty oil. *Seed:* A source of fatty oil (56%) and protein (28%); oil bitter but can be removed by refining.

A. excelsa Roxb. TREE-OF-HEAVEN

Guj–*Adusa;* Hindi & Mar–*Maharukha;* Kan–*Hemaraheeramara;* Mal–*Mattipongilyam;* Oriya–*Mahala;* Sans–*Madala-aralu;* Tam–*Perumaruttu;* Tel–*Peddamaanu.*

Rajasthan–*Arua;* TRADE–*Maharukh.*

Habit—A large, fast-growing tree, up to 24 m/2.5 m. *Stem*—straight, cylindrical. *Bark*—light grey, smooth in young trees, with large scars; rough, granular, greyish-brown in older trees, with conspicuous leafscars. *Leaf*—pinnately compound, up to 90 cm, with 8–14 pairs of leaflets. *Flower*—small, yellowish, in panicles; February–March. *Fruit*—1-seeded samara, twisted at the base, 5.0–7.5 cm × 1.2–1.7 cm; dispersed by wind;



Ailanthus excelsa

May–June. *Seed*—9500/kg; February; germination 7–14 days, 30–70%; viable for 1year.

Distribution and Ecology—Indigenous to South and Central India, found in Madhya Pradesh, Gujarat, coastal Andhra Pradesh and Orissa; extensively cultivated as an avenue-tree in low-rainfall regions. Grows on porous-loamy skeletal, arid, sandy soils, and eroded, ravinous land and in *terai* and *babhar* zones.

Silvicultural Characters—Excess of moisture should be avoided in the early stages. Needs weeding. Growth is quick; easily broken by wind. Seedlings sensitive to drought and frost. Coppices well; produces rootsuckers.

CULTIVATION/REGENERATION

Natural Regeneration—Not good in forests, probably due to sensitiveness of the seedling and intolerance of weeds. Generally, seeds germinate after the first rains.

Artificial Regeneration—Can easily be raised from seed or shoot- and root-cuttings. Seed is sown in May or June in raised beds at 15 cm × 20–25 cm and regularly, but sparingly, watered. Needs regular weeding and protection from frost. One-year-old seedlings withstand transplantation. Transplanted during July–August.

UTILIZATION

Reclamation—Since fast-growing and immune to attack from livestock and suited to many types of soils, it is recommended for anti-erosion, even on eroded gullies and ravines and for reclamation of wastelands, such as saline, alkaline, and semi-arid areas and sand-dunes. Recommended for agro- and social forestry; grown as an avenue-tree for its deep shade.

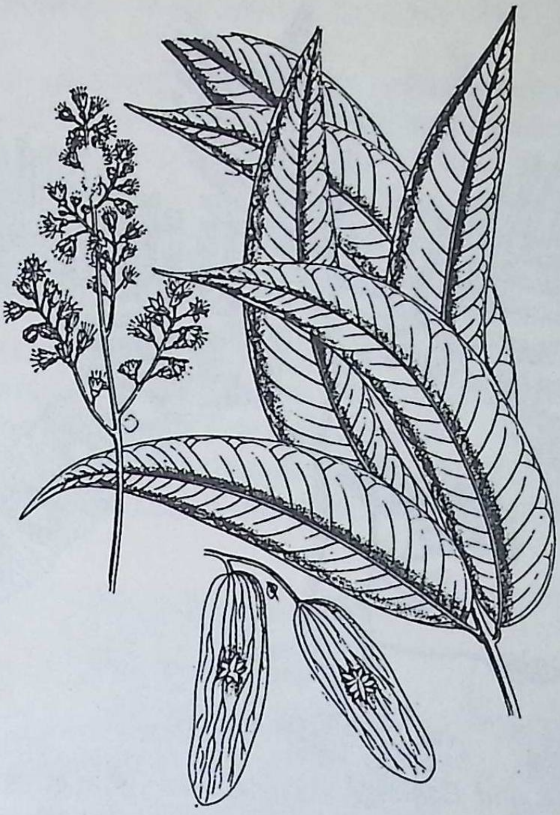
It is a good bee-pasture.

Timber—Catamarans, small boats, veneers, plywood, packing-cases, toys; matchwood though poor; and for pulp.

Fodder—Leaf lopped (crude protein, 19.8%). Food for *eri*-silkworms.

Others—*Bark:* Yields an inferior-quality gum, called BASSORA or HOG. Bitter, astringent, febrifuge, stomachic, anthelmintic, antispasmodic and expectorant; used in bronchitis, asthma and dysentery, and earache; possesses antiseptic properties. A good substitute for that of *Holarrhena antidysenterica;* used in veterinary practice. *Leaf:* Extracts antiviral. *Rootbark:* Yields quassinoids; exhibits antitumour and cytotoxic activity.

A. triphysa (Dennst.) Alston syn. *A. malabarica* DC. is suited for grassy blanks and recommended for social forestry.



A triphysa

ALBIZIA Durazz. (*Mimosaceae*)

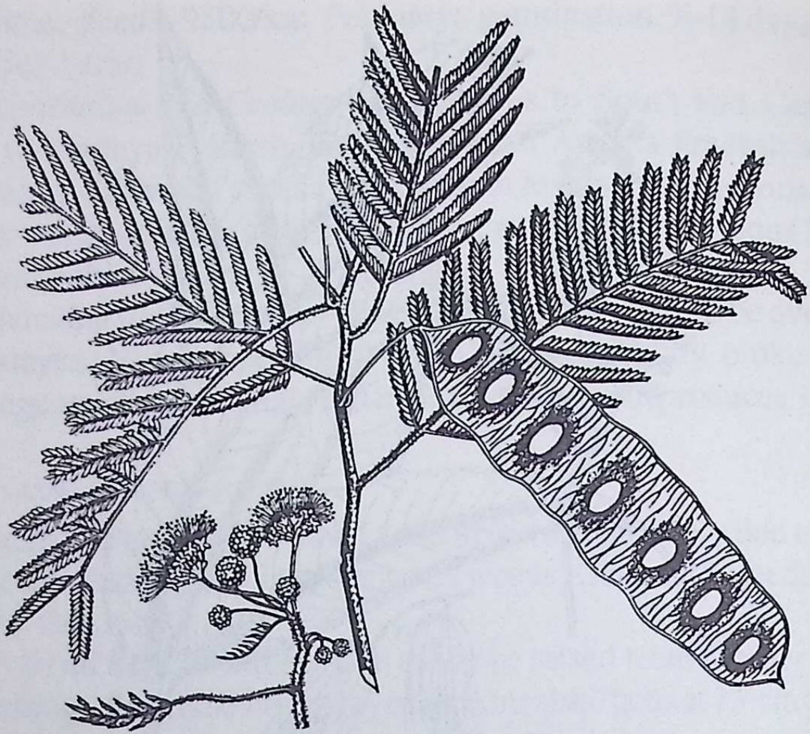
Medium-sized trees; mostly confined to tropical and subtropical Asi Africa and Australia; 12 spp in India.

Useful in reclamation; also yield timber and medicinal products.

A. amara Boiv.

Guj–*Motosarasio;* Kan–*Chigare;* Mal–*Varacchi;* Mar–*Lallei;* Sans–*Krishnasirisha;* Tam–*Thurinjal;* Tel–*Nallarenga, chinguruchettu.*

Habit—A moderate-sized, deciduous, unarmed tree. *Stem*—crooked, much-branched, 3 m/0.6–0.9 m; branchlets pubescent. *Bark*— smooth, dark greenish, scaly. *Leaf*—paripinnate: leaflets 15–30 pairs, membranous with a gland between the lowest pair. *Flower*—yellow, fragrant, in peduncled heads; April–June. *Fruit*—thin, flat, greyish-brown or reddish-brown, pubescent, undulate-edged pod, 10-20 cm long; cold season, chiefly from November to January. *Seed* —13,700–14,470/kg; February–April; germination 70–100%; viable for very long period ; needs hot-water treatment or scarification.



Albizia amara

Distribution and Ecology—Native to drier regions of South India, Maharashtra and in a few localities in Madhya Pradesh on dry, often hilly, country, with a rainfall ranging from 25 to 1500 mm. Found on deep sandy or shallow sandy loam soils or marginal subdry zone on the Coromandel coast in Andhra Pradesh and Tamil Nadu; and in thickets and in ferruginous, ferralitic and skeletal soils, and sandstone.

Silvicultural Characters—Freely coppices and suckers. Thinning of coppice-shoots is necessary.

CULTIVATION/REGENERATION

Natural Regeneration—Good if protected from fire and grazing, particularly by goats. Also occurs through rootsuckers.

Artificial Regeneration—Direct sowing of seed or transplanting the seedlings.

UTILIZATION

Reclamation—Acidophilous species. Recommended for the reclamation of wastelands as mentioned above and in arid zones; planted for afforestation, shelterbelts and windbreaks. In South Kerala, it is chiefly grown for green-manuring paddy. Fixes nitrogen.

Timber—Toolhandles, mallet-heads, agricultural implements, carving, turnery, cabinet-making; also for pulp.

Fuel—Excellent firewood (sapwood, 5049 kcal; heartwood, 5306 kcal/kg).

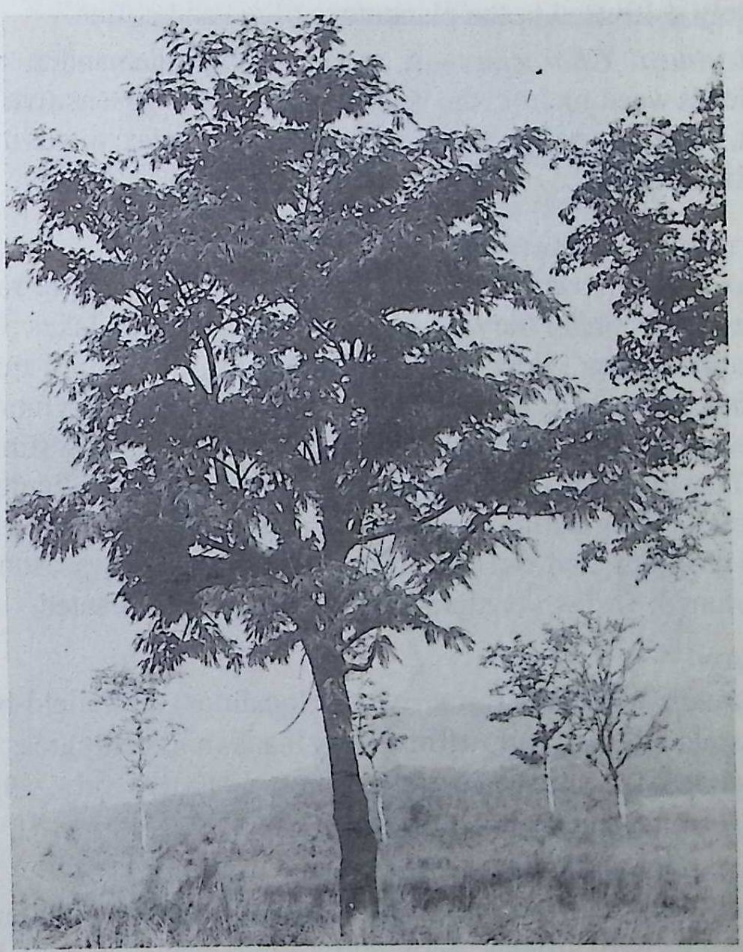
Fodder—Leaf lopped for emergency cattle-feed (crude protein, 13.5%).

Others—Bark: Yields a gum; cooling and useful in erysipelas, eye-diseases, inflammations and ulcers. *Leaf:* Used in ophthalmia and as hairwash; adulterant to tea. *Flower:* Cooling; applied to boils, eruptions and swellings. *Seed:* Astringent and given in piles, diarrhoea, gonorrhoea. Yields an oil (5.2%); reported to cure leprosy and leucoderma.

A. chinensis (Osbeck) Merrill syn. *A. stipulata* Boiv.

Beng–*Chakua;* Hindi–*Siran;* Kan–*Kalbage;* Mal–*Pottavaga;* Mar–*Laeli;* Tam–*Pilivagei;* Tel–*Kondachigera.*

Assam–*Saukoroi;* Cachar–*Bonphru-phang;* Garo–*Beolphiu;* Khasi–*Dieng-phyneat;* Lushai–*Bongsip;* Manipur–*Luang khoi.*



A. chinensis

Habit—A large, deciduous tree, with broad, spreading flat-topped crown. *Stem*—cylindrical bole of 9 m/2.4 m. *Bark*—dark grey, fairly smooth, with occasionally prominent, horizontal and numerous small, vertical wrinkles and furrows. *Leaf*—paripinnate, with 8–15 pairs of lanceolate leaflets, feathery, with large stipules. *Flower*—feathery, yellowish-white, in terminal or axillary panicles; April–June. *Fruit*—flat, glabrous, light brown, often wrinkled over seeds, 8–15 cm × 1.25–2.5 cm, 8–12-seeded; November–December; continues to hang on tree even when dry. *Seed*—flat, ovate, elliptic, greenish-brown, smooth 5–7 mm long; 32,143/kg; germination 7days, 50%; viable for 1–2 years; needs hot-water treatment or scarification.

Distribution and Ecology—Throughout the sub-Himalayan valleys, up to 1200 m, in Assam, West Bengal, Bihar, South India and in the Andamans, with a rainfall of 1125–5000 mm or more. Chiefly occurs in moist localities, often on swampy ground and moist low-lying savannah. Extensively cultivated in the plantations of tea and coffee.

Silvicultural Characters—A moderate light-demander; withstands shade. Needs weeding from the young stage. Seedlings sensitive to drought and frost, but have good power of recovery; in dry areas, weeds may protect it from drought.

CULTIVATION/REGENERATION

Natural Regeneration—Germination starts early during rains and is completed early under the sun; sometimes germination takes place in the second rainy season. Loose soil and a fair degree of moisture are essential.

Artificial Regeneration—Direct sowing of fresh seed is more successful than transplanting; regular weeding from the beginning stimulates the growth. Transplanting can be carried out without much difficulty, particularly in line-sowing during rainy season; seed sown in nursery in March–April, 25 cm apart, and watered and weeded through dry season. Seedling may be pruned. Growth is rapid. Stumps can also be planted.

UTILIZATION

Reclamation—Can be raised in moist localities and on field-boundaries and in wastelands; can be grown on grassy blanks and sandy areas in islands. Recommended for agro- and social forestry. Extensively cultivated in plantations of tea and coffee. Fixes nitrogen.

Plant extract piscicidal and oxytocic.

Timber—Boxes, packing-cases, matches, planking, dugouts, well-curbs, small turnery articles, agricultural implements; suitable for paper-pulp with long-fibred pulp.

Fuel—Good firewood (sapwood, 4353 kcal; heartwood, 4845 kcal/kg).

Fodder—Leaf lopped (crude protein, 15.1%); continuous feeding may lead to toxic condition.

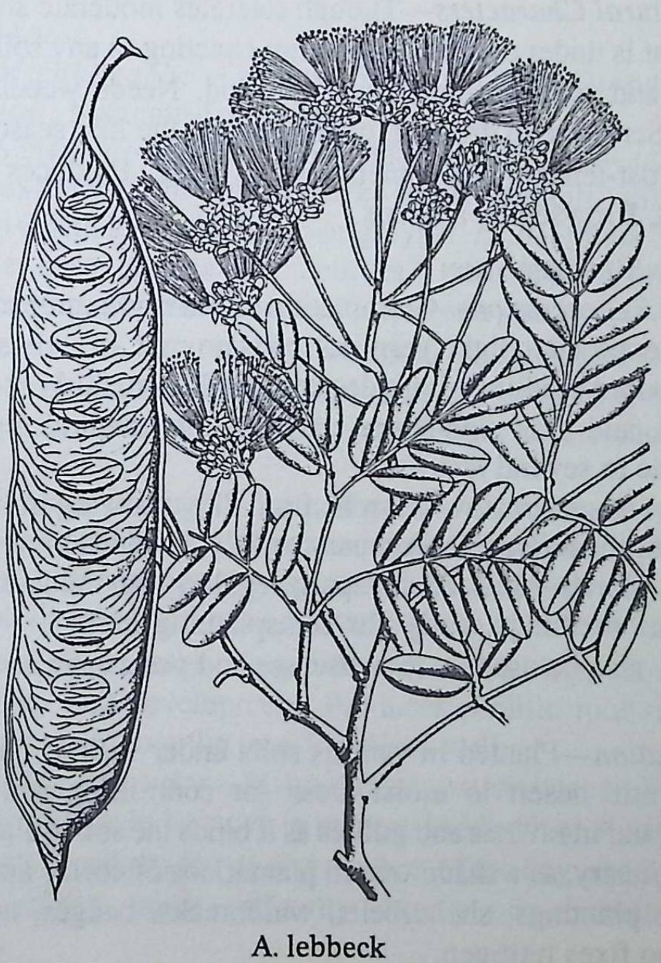
Others—Bark: Yields a gum used for sizing papers; also tannins (22%); infusion used for cuts, scabies, etc. as lotion. *Leaf:* Along with seeds toxic to melon-worm larvae and cotton-stainer adults.

A. lebbeck Benth. THE EAST-INDIA WALNUT, THE SIRIS TREE

Beng–*Sirish;* Guj–*Pilosarasio;* Hindi–*Siris;* Kan–*Bagemara;* Mal–*Vag;* Mar–*Chichola, sirisha;* Tam–*Vagei;* Tel–*Dirisana, sirisha.*

Assam–*Kothia koroi;* Cachar–*Moroi;* Khasi–*Dieng-salvrin;* Lushai–*Rumri;* TRADE–*Kokko.*

Habit—A large, deciduous, spreading tree, up to 30 m/1.8–3 m. *Stem*—a short bole, with low crown in open forests; in closed forests, a clear bole up to 9 m. *Bark*—dark brown to greenish-black, rough with longitudinal



A. lebbeck

and transverse fissures on outer surface, inner whitish with fine longitudinal striations. *Leaf*—bipinnate, 8–18 leaflets. *Flower*—greenish-yellow or white, highly fragrant, in globose heads; April–May or later. *Fruit*—yellowish-brown, strap-shaped, thin, firm, linear-oblong, 6–12-seeded pod; 20–30 cm × 4–5 cm; August–November; matures in December; rains bring down; pods make characteristic sound when rustle. *Seed*—obovate-oblong, compressed, light brown, smooth; 8000–13,000/kg; January–March; germination 60 days, 70–100%; viable for more than 1year; needs hot-water treatment or scarification.

Distribution and Ecology—Very common all over India from the plains, up to 900 m in the Himalayas, and in the Andamans. Found to grow on a variety of soils in arid, semi-arid and semi-moist zones; alkaline, saline, black, shallow soils overlying hard calcareous pans, alluvial laterite, skeletal, deep and shallow sandy arid tract, shifting sand-dunes, ravines, gullies and mining-sites.

Silvicultural Characters—Though tolerates moderate shade, the best development is under overhead light; not exacting to any soil; rootsystem superficial and may be blown off by wind. Needs weeding from the beginning. Sensitive to drought, particularly in the first season. Seedlings not very frost-tender, but sometimes die back. Produces rootsuckers. Growth fast. Browsed by animals.

CULTIVATION/REGENERATION

Natural Regeneration—Germination ordinarily commences early during rains; if exposed to light, germination is prompt. In early stages, weeds help the exposed seedlings from desiccation. Loose, fairly moist soil, free from weeds, and light side-shade are ideal. But, natural regeneration is uncertain due to several factors.

Artificial Regeneration—Can be from direct sowing in lines or transplanting from the nursery in February or July; sowings in nursery may be done during March–April, 25 cm apart; regularly but moderately watered; well-weeded; seedlings ready for transplanting early in rainy season. Stumps may also be used. A few diseases and pests have been recorded.

UTILIZATION

Reclamation—Planted in various soils under various climatic conditions from arid desert to moist areas for controlling soil-erosion and reclamation and in ravines and gullies as it binds the soil. Suitable for agro- and social forestry, as a shade-tree in plantations of coffee and cardamom, for roadside plantings, shelterbelts, windbreaks, hedges, and for green manure. Also fixes nitrogen.

Timber—Substituted for teak and *sal*. High-class furniture, internal decoration, panelling, parquet- and ship-flooring, railway-carriages, carts and carriages, construction; and paper-pulp.

Fuel—Very good firewood (sapwood, 5163 kcal; heartwood, 5166 kcal/kg).

Fodder—Leaf yields a nutritious, palatable fodder (crude protein, 20.1–21.1%).

Others—Bark: Yields a gum; used as adulterant to or substitute of gum arabic. Yields tannins (7–11%); used for fishing-net. Used for boils and as astringent, expectorant and anthelmintic, and given in piles and diarrhoea. *Leaf:* Used in eye-troubles. *Leaf & Pod:* Larvicidal. *Rootbark:* Used as dental powder for strengthening gums. *Flower:* Yields a sweet-smelling oil (4.3%). *Seed:* Possibly be included in animal diet (crude protein, 39.5%); contains saponins having anti-ovulatory properties.

A. lucida Benth.

Beng–*Sil koroi*.

Assam–*Michhagaeh;* Cachar–*Sundi;* Khasi–*Dieng-sa-rynto;* Lepcha–*Ngraem;* Manipur–*Luang-khioi*.

Habit—A medium-sized tree, with silky shoots. *Stem*—tall, cylindrical, straight, reaching 1.5 m in girth. *Bark*—nearly smooth, with horizontal wrinkles, warty with lenticels, green or greyish. *Leaf*—pinna 3.7–7.0 cm, with a gland at base: leaflets 2, sometimes 3 pairs, oblong-lanceolate or lanceolate. *Flower*—yellowish-white, in heads on peduncles; April–May. *Fruit*—deep brown, 15–30 cm×2.5–3.0 cm, 6–8-seeded; February–April. *Seed*—orbicular or broadly elliptic, 1.0–1.25 cm long, light brown, flat, smooth, with leathery testa; 21,000/kg; readily germinates; loses vitality quickly.

Distribution and Ecology—From Nepal to Assam and Meghalaya, up to 750 m; often planted along avenues and in gardens. Found wild along the banks of streams and in moist places; grows best on clayey soils, but can be raised successfully in dry and semi-arid zones; also found on alluvial plains.

Silvicultural Characters—Somewhat shade-bearing; requires moist situations for the best development. Produces prolific root-suckers to a considerable distance from the tree. Coppices well.

Cultivation/Regeneration—Natural regeneration occurs. For artificial regeneration, seed should be sown in nursery in March or April; beds kept moist and weeded, and shaded during the heat of the day; seedlings can be transplanted without much difficulty during rains; rootsuckers are recommended.

UTILIZATION

Reclamation—Recommended for dry and semi-arid zones. Host for lac-insect.

Timber—Posts, rafters, scantlings.

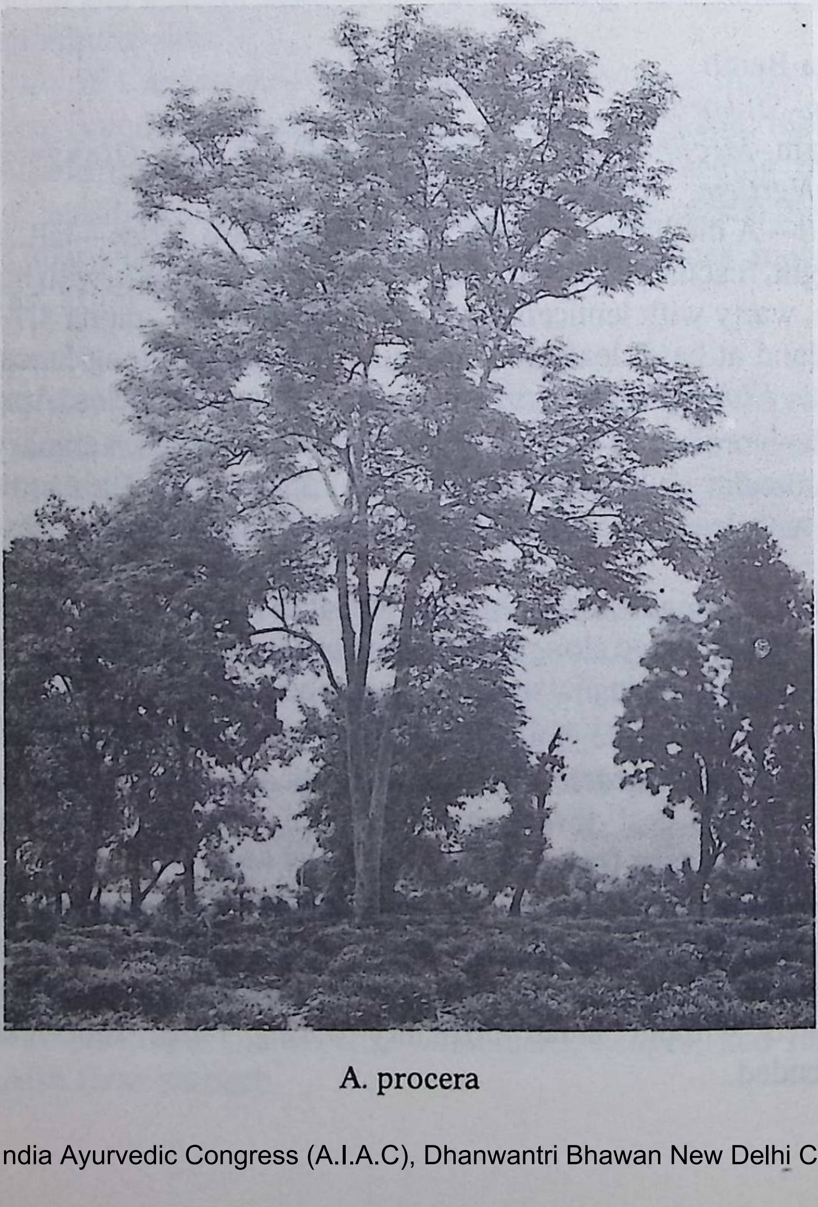
Others—*Seed:* Edible; tastes like hazelnut; oily (12.4%); protein useful for adhesives for commercial plywood.

A. procera Benth. WHITE SIRIS

Beng–*Koroi;* Hindi–*Safed siris;* Kan–*Bellate;* Mal–*Karunth-agara;* Mar–*Kinhai;* Tam–*Kondavagei;* Tel–*Tellachinduga.*

Assam–*Korai;* Cachar–*Jigring-bon-phayng;* Garo–*Khereuvi;* Khasi–*Dieng-rilong;* TRADE–*White Siris.*

Habit—A large, deciduous, straight-stemmed tree, often branching at a considerable height, with somewhat light crown, 18–24 m/1.8–2.1m or



A. procera

more. *Stem*—long, clean bole, up to 15 m. *Bark*—smooth, light yellowish or greenish-grey, exfoliating in thin flakes, red inside. *Leaf*—30–45 cm long: leaflets 6–16 pairs, oblique, oblong-ovate or rhomboid-oblong. *Flower*—yellowish-white, in heads on large, terminal panicles; June–September. *Fruit*—thin, strap-shaped, glabrous, rich-red or reddish-brown, flexible, 6–12-seeded pod, 10–20 cm× 1.25–2.0 cm; October–January; ripen from February to May. *Seed*—flat, elliptical to nearly orbicular, hard, smooth, greenish-brown with a leathery testa; 20,000–21,786/kg; readily germinates; germination 21days, 80–90%; viable for more than 2 years; needs hot-water treatment or scarification.

Distribution and Ecology—Found in the sub-Himalayan tract from the Yamuna eastwards to West Bengal, Madhya Pradesh, Gujarat and in South India, and the Andamans. Common on alluvial soils along streams and in moist, even swampy places, particularly common in low-lying, moist savannahs; suitable to grow on saline, alkaline and brackish-water soils.

Silvicultural Characters—A light-demander but tolerates moderate shade. Fairly drought-resistant but not frost-hardy. Produces rootsuckers when the aerial portions are mutilated or age advances. Growth rapid. Subjected to cankerous wounds where branches break.

CULTIVATION/REGENERATION

Natural Regeneration—Very satisfactory; plenty near seed-bearers during the rains; plentiful moisture and bare loose soil are necessary; abundant on new, soft, alluvial ground near rivers; may be found in quantity in moist grassy tracts.

Artificial Regeneration—Direct sowing proved more successful than transplanting in loose soil in lines. Transplanting can be done during wet weather, either entire or pruned; seeds are sown during March–May, 25cm apart. Readily grows from cuttings also.

UTILIZATION

Reclamation—Useful for afforesting low-lying savannahs and moist alluvial tracts and sandy loam soils. Although natural reproduction is often good, artificial reproduction is needed for afforesting. Can be grown for reclaiming saline, alkaline, brackish-water soils, minespoils and ravines. Suitable for growing in irrigated areas in conjunction with field-crops; grown as shade-tree and recommended for social forestry. Fixes nitrogen.

Timber—Good substitute for teak and *sal*. Carriages and carts, furniture, posts, beams, planks, agricultural and household implements; and for pulp.

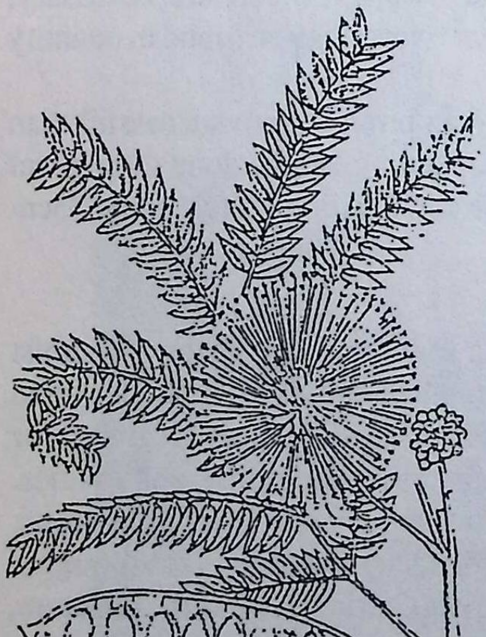
Fuel—Used as firewood (sapwood, 4870 kcal; heartwood, 4865 kcal/kg).

Others—All parts show anticancer activity. *Bark:* Decoction given in rheumatism and haemorrhage; used as fish-poison. Yields a gum which compares well with gum arabic. *Leaf:* Good source of nitrogen. Yields tannins (3.2%). *Root:* Contains saponin which shows spermicidal activity. *Seed:* Contains toxic principle (protein, 30.5%).

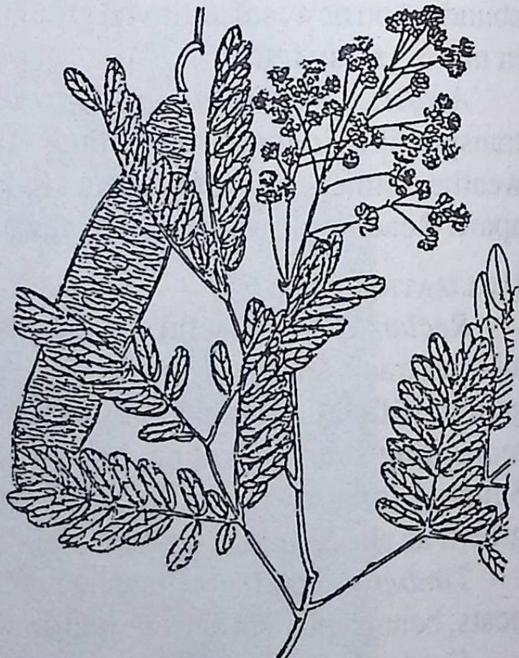
A. distachya (Vent.) Macbr. syn. *A. lophantha* Benth. is a tall shrub or small tree, native to Australia, naturalized in Himachal Pradesh and on the Nilgiris, useful for planting on denuded slopes. *Seed:* Yields oil (8%) and protein (32.5%). Fixes nitrogen.

A. falcataria (Linn.) Fosberg syn. *A falcata* (Linn.) Backer; *A. moluccana* Miq. is a fast-growing tree, up to 25 m, with 45cm long leaf, having 4–12 pairs or pinnae and 15–25 pairs of falcate leaflets, white to light-green flowers in glabrate, branched panicles and 12 cm long, up to 15-seeded pod, native to South-East Asia, successfully introduced into India, for reforestation; suitable for grassy bauxite-mined lands, grassy blanks and for shade in tea-gardens. Recommended for agroforestry. Fixes nitrogen.

A. julibrissin Durazz. (PINK SIRIS; HILL-SIRIS; Hindi–*Lal siris*) is a fast-growing tree, found in outer Himalayas to Sikkim, up to 2100 m; freely produces rootsuckers; can be propagated from root-cuttings. Useful for afforesting unstable hillsides; recommended for agroforestry. Fixes nitrogen. *Leaf:* Yields tannins. *Seed:* Yields oil (11.1%) and protein (33%).



A. julibrissin



A. odoratissima

A. odoratissima Benth. (BLACK SIRIS; Beng–*Kakcur siris;* Guj–*Kalo sarasio;* Hindi–*Kala siris;* Kan–*Bilvara;* Mal–*Pulivaga;* Mar–*Chikunda;* Tam–*Karuvagei;* Tel–*Chinduga;* TRADE–*Black Siris*) is a large tree, with a bole of 7.5–9.0 m, found in the sub-Himalyan tract on slopes, up to 1500 m, and also common in Assam, West Bengal and in peninsular India; grown for shade. Recommended for upper hillslopes and crest grassslands and ravines; fixes nitrogen. Yields tannins (6.09%). *Timber:* Can be substituted for teak and *sal;* used for carts, agricultural implements, furniture, etc.; also a good firewood (sapwood, 5131kcal; heartwood, 5200 kcal/kg). *Bark:* Yields a gum. *Leaf:* Lopped for fodder; yields tannins (5.14%). *Seed:* Contains protein (38.6%).

A. richardiana King & Prain, an exotic species, has been cultivated in avenues and for shade in gardens and recommended for agroforestry, and grassy blanks.

ALNUS Mill. (*Betulaceae*)

Deciduous trees or shrubs; temperate Asia, Europe and America; 2 spp in India.

A. nepalensis D.Don INDIAN OR NEPALESE ALDER

Hindi–*Uitis.*

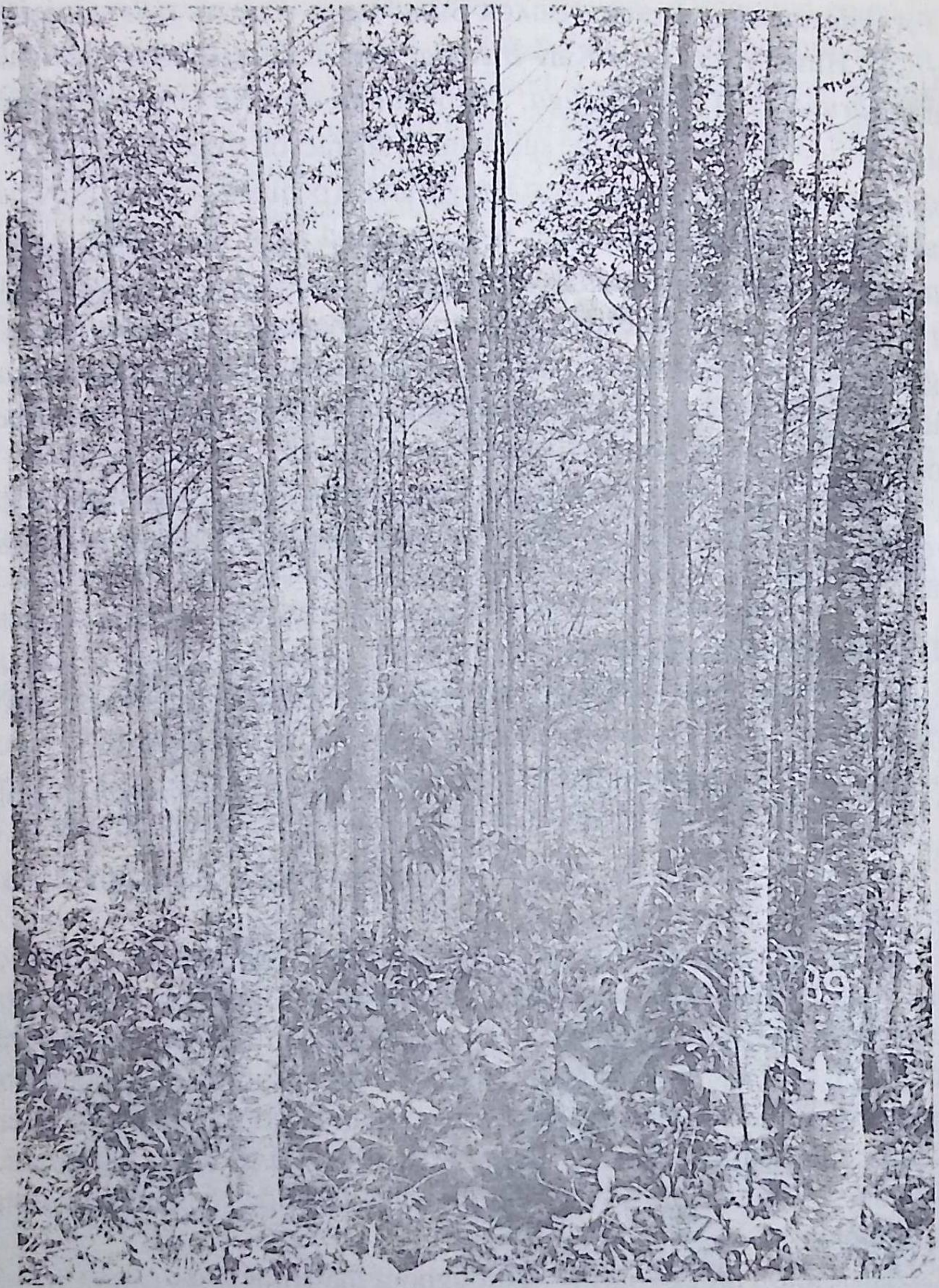
Arunachal Pradesh–*Udis;* Chamba–*Piak;* Kumaun–*Udish;* Lepcha–*Koyal;* Punjab–*Koe.*

Habit—A sparsely branched, deciduous tree, with straight, cylindrical bole, 20–30 m/1.8–2.4 m. *Leaf*—elliptic-lanceolate, entire or slightly denticulate, 7.5–20.0 cm. *Inflorescence*—male spikes 10–25 cm, in terminal, drooping panicles; female spikes 0.6 cm, pendulous; fully developed from September to November. *Fruit*—winged nuts in cones, on erect, lateral racemes; December–March. *Seed*—218,100–570,000/kg; germination 28–42days, 70%; viable up to 6 months; storage at low temperature; needs stratification.

Distribution and Ecology—Throughout the Himalayas from Chamba in Himachal Pradesh to Mishmi hills in Arunachal Pradesh and Khasi hills in Meghalaya, commonly below 1800 m, occasionally up to 2700 m. Grows in moist, shady ravines near water to clayey soils, usually in gregarious strips, but not so strictly confined as *A. nitida* in the western Himalayas. Grows on exposed soils forming pure patches.

CULTIVATION/REGENERATION

Natural Regeneration—Easily regenerates and forms pure patches.



Alnus nepalensis

Artificial Regeneration—Easily raised from direct sowings on bare, loose ground, preferably in lines; or from transplanting; seed *in situ* or in the nursery in February or March; 3–4-month-old, 10–15- cm-high seedlings transplanted in the rains; occasionally planted in wet ravines where nothing else grows. Growth is rapid; needs protection from deer. Commonly cultivated with agricultural crops.

UTILIZATION

Reclamation—Can be grown in wet soils near watercourses to prevent erosion and landslips, on nearly exposed lands or abandoned lands for reclamation and prevention of erosion. Regularly planted under agro- and also social forestry.

A non-leguminous plant which fixes nitrogen and helps in improving the soil.

Timber—Teaboxes, house-building, carpentry, plywood; and pulp.

Fuel—Yields a good firewood.

Fodder—Leaf sometimes lopped for fodder.

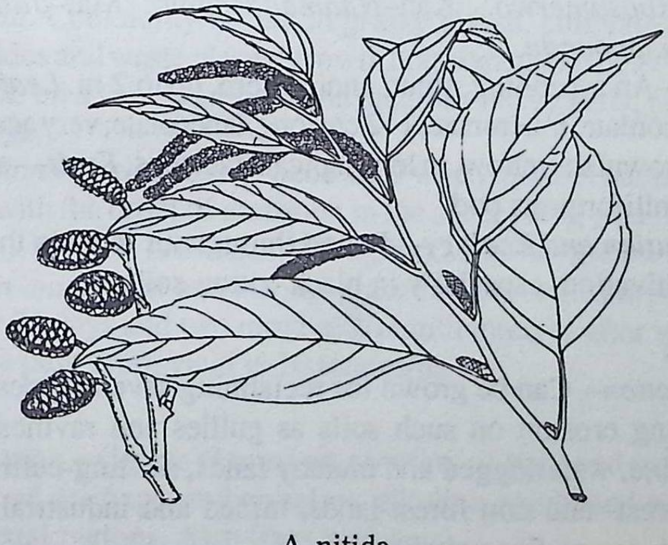
Others—*Bark:* Yields tannins (7%); used in dyeing to deepen the colour of Indian madder.

A. nitida Endl. THE WEST-HIMALAYAN ALDER

Kashmir–*Seril;* Punjab–*Sharol;* Uttar Pradesh–*Kunis.*

Habit—A large, deciduous tree, with a straight stem, up to 30 m/4 m. *Bark*—dark brown, rough, with deep furrows. *Leaf*—elliptic-ovate, 10–20cm long, acuminate, entirely or obtusely crenate. *Inflorescence*— male spikes 5cm long, in terminal, erect, often leafy racemes; female spikes 2.5–5.0 cm; fully developed from August to October. *Fruit*—nut, with narrowly thickened margins; ripens during November--December; empty cones remain long on the tree. *Seed*—885,987/kg; viable till 6 months; storage at low temperature; needs stratification.

Distribution and Ecology—In western Himalayas from the Yamuna westwards to Kashmir, at 900–2700 m. Always found in moist situations, mainly along the beds and banks of streams and rivers; gregariously springs



A. nitida

up pure on new lands, sometimes to a considerable extent, in riverbeds; also springs up in strips along the banks of moist ravines and torrents.

CULTIVATION/REGENERATION

Natural Regeneration—Abundant.

Artificial Regeneration—Natural seedlings are plenty and can also be transplanted. Easily propagated from direct sowing or sown in moist, shady nurserybeds in February; 2–3-years-old seedlings can be transplanted in moist situations; cuttings can be planted in moist, sandy nurserybeds during rains and transplanted in winter or rainy season after rooting well.

UTILIZATION

Reclamation—Can be planted for reclamation of newly exposed lands, stream and riverbanks and other wastelands. Recommended for agro- and social forestry. Fixes nitrogen and improves soil.

Timber—Largely used for house-building, for bedsteads, carts and solid wheels; hooked sticks in rope-bridges.

Others—Twig: Used for making basket. *Bark:* Yields tannins (3%) and a dye.

ALYSICARPUS Neck. ex Desv. (*Fabaceae*)

Annual or perennial herbs; warmer Africa and Asia to Australia; 20 spp in India.

Common weeds in grassy savannahs, wastelands and along roadsides; fix nitrogen.

A. longifolius Wight & Arn.

Guj–*Usbosamerwo;* Kan–*Naamadasoppu;* Mar–*Jangli gaulia;* Tam–*Naamappoondu.*

Habit—An ascending, stout, annual herb, up to 2 m. *Leaf*—unifoliate: leaflets subcordate, mucronate, 1–2 cm long, lanceolate, very acute. *Flower*—yellow or brownish-yellow, in long, spicate racemes. *Fruit*— short-stalked, downy, moniliformous pod.

Distribution and Ecology—Found throughout India in the plains, as a weed of cultivation, especially in black cotton-soils.

UTILIZATION

Reclamation—Can be grown for reclaiming several types of soils and for preventing erosion on such soils as gullies and ravines, undulating uplands, saline, waterlogged and marshy lands, shifting-cultivation areas, degraded forest- and non forest-lands, mined and industrial wastelands; forms a thick cover; fixes nitrogen.

Fodder—Given as fodder; makes a good composition with grasses in pastures.

Others—Root: Sweet; used as a substitute for liquorice.

A. monilifer (Linn.) DC. syn. *A. vaginalis* Hochst. & Baker, non auct.

Tam–*Kalanaamapoondu;* Tel–*Amera.*

Delhi–*Chatta-ki-ghas;* Mundari–*Maditased.*

Habit—An annual herb, up to 60 cm. *Stem*—clothed with fine, spreading hairs when young. *Leaf*—simple, oblong-elliptic to sub-orbicular, often cordate. *Flower*—orange-yellow, pink or red, in erect, 4–5-flowered racemes. *Fruit*—moniliformous, turgid hairy, 4–8-jointed pod.

Distribution and Ecology—Throughout India, especially along the coast. Occurs as a weed in sandy areas and in pastures. Drought-resistant.

UTILIZATION

Reclamation—Often associated with other turf-forming legumes; fixes nitrogen.

Fodder—Fed to cattle; makes good silage.

A. rugosus (Willd.) DC. syn. *A. violaceus* Schindl.

Guj–*Guchhalo samerawo;* Mar–*Gehuna;* Tam–*Naamapoondu;* Delhi–*Sheora.*

Habit—A copiously branched, erect or sub-erect shrub, 30–60 cm. *Leaf*—uni- or trifoliolate: leaflets usually oblong, rarely orbicular or linear-lanceolate. *Flower*—purplish-blue, in dense, terminal racemes. *Fruit*—glabrous, apiculate, 9–10 mm long, with characterstic transverse wrinkles.

Distribution and Ecology—Throughout India in the plains and on hills, up to 1500 m. Commonly occurs in grassy places, cultivated fields, pastures, roadsides and waste places; growth luxuriant under heavy rainfall and warm climate on a variety of light and medium-heavy soils, provided with good drainage.

Cultivation/Regeneration—Seed shed when mature; natural regeneration begins with the onset of monsoon in the succeeding year. For artificial regeneration, seed is broadcast (15 kg/ha); can be grown mixed with *Dichanthium annulatum* and Napier-grass (*Pennisetum purpureum*); first cutting after 75 days and two more at 2-month interval after which left for seeding; as a pure crop, yield is 10 tonnes/ha.

UTILIZATION

Reclamation—Can be planted on a variety of light and medium-heavy soils with good drainage, and on saline, alkaline, sandy and sandy loam in arid and coastal regions. Also fixes nitrogen.

Fodder—Leaf highly succulent, palatable and nutritious (crude protein, 18%).

A. vaginalis DC. ALYCE CLOVER, ONE-LEAVED CLOVER

Guj–*Gaadar samerwo;* Mar–*Dhakta dhampta;* Tam–*Naamapoondu.* Mundari–*Bir but, ote jatain ba.*

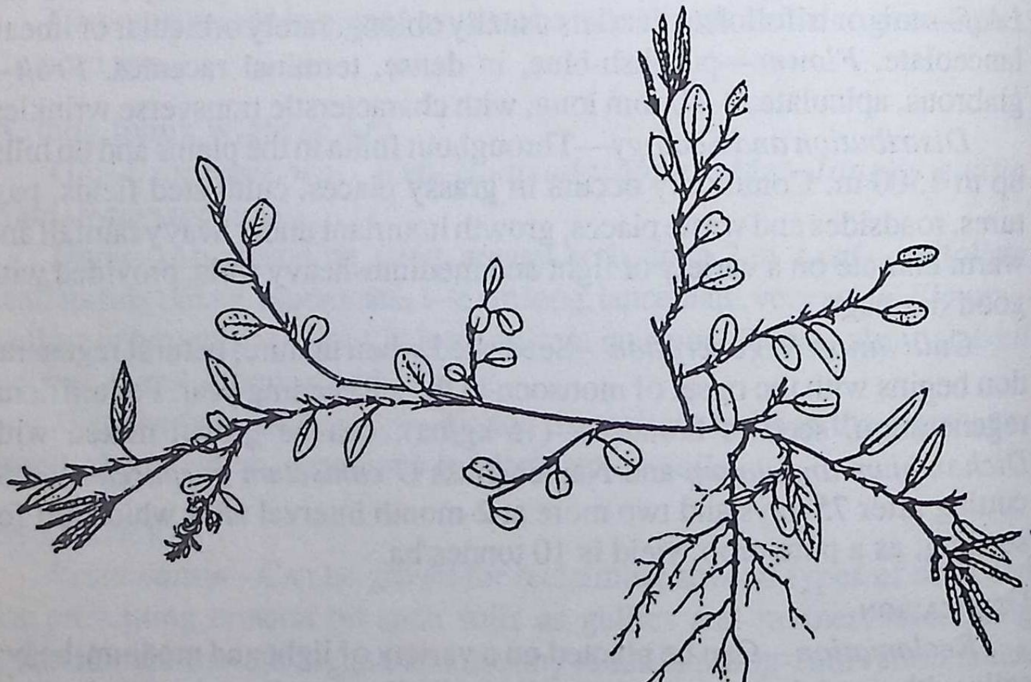
Habit—A decumbent, ascending or prostrate, annual herb, 30–90 cm. *Leaf*—variable in size, hairy, cordate, suborbicular or broadly oblong, upper one ovate-lanceolate. *Flower*—small, red or pinkish-yellow, in axillary or terminal, lax racemes. *Fruit*—nearly round or cylindrical, 2–5 cm long, 6–9-jointed pod. *Seed*—smooth, brownish-yellow, 2 mm in diam.

Distribution and Ecology—Commonly occurs all over India, both in plains and hills, up to 1200 m. Found in open pastures and lawns, on clayey and sandy soils. Drought-resistant but does not tolerate wetlands.

UTILIZATION

Reclamation—An excellent soil-improver; recommended for terraced fields on the hills. Can be grown as green manure in coconut plantations. Fixes nitrogen.

Fodder—Given as fodder (crude protein, 13.3%) and also in association with pasture-grasses; hay also can be made.



Alysicarpus vaginalis

Others—Herb: Credited with anti-pyretic and expectorant properties. *Leaf:* Purgative; extracts show anticancer activity. *Root:* Urinary troubles and leprosy; decoction in cough. *Seed:* Yields an industrial gum.

A. belgaumensis Wight is an annual herb, 30–69 cm high, found in Maharashtra, cultivated for pasture (crude protein, 2.1%).

ANACARDIUM Linn. (*Anacardiaceae*)

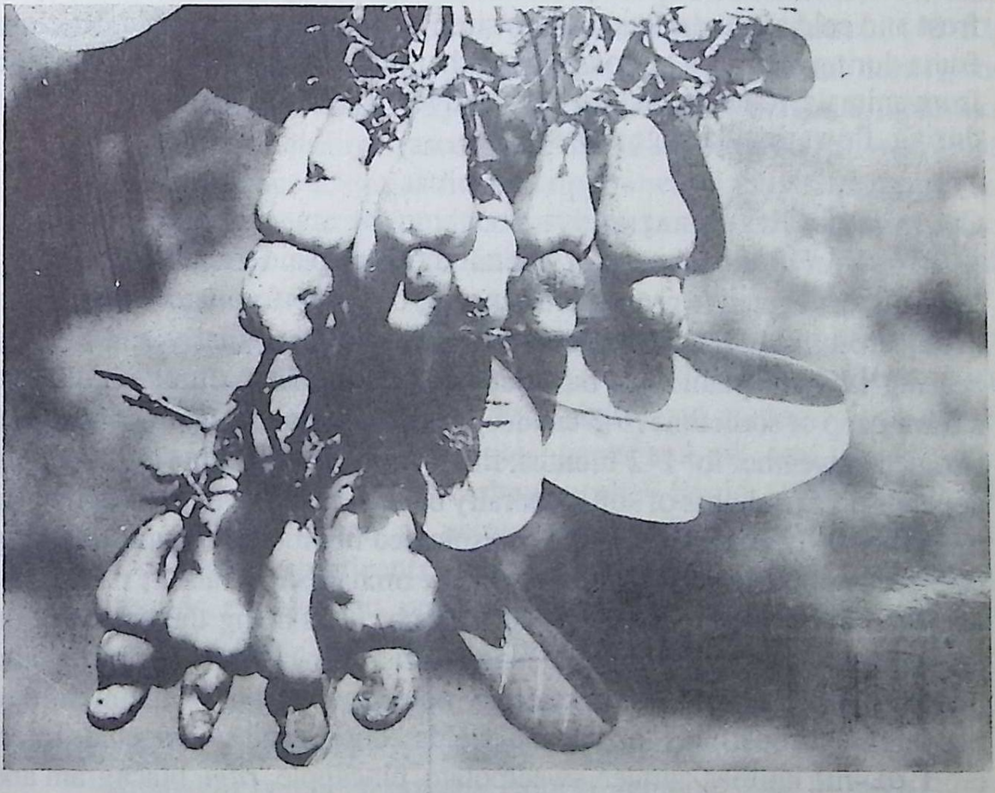
Oleaginous shrubs and trees; tropical America; 1 sp naturalized in South India.

A. occidentale yields the famous CASHEWNUT, besides being used for reclamation.

A. occidentale Linn. THE CASHEW-TREE

Beng, Guj, Hindi, Mar–*Kaaju;* Kan–*Gerabija, jidivate;* Mal–*Andiparuppu, kashumavu* (tree); Tam–*Mundirikottai;* Tel–*Jeedimaamidichettu* (tree), *jeedianti, jeedipappu* (seed).

Habit—A much-branched tree, 8–12 m. *Leaf*—obovate or obovate-oblong, obtuse-retuse or rounded tip, 10–12 cm long; hard, coriaceous,



Anacardium occidentale

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glabrous above. *Flower*—small, yellow with pink stripes, staminate and hermaphrodite, in terminal, 15–25 cm long panicles; flowering starts when 2-year- old; appears in 2 or 3 waves; November–February. *Fruit*—greyish-green, hard, smooth, shining, oleaginous, kidney-shaped, 1-seeded nut, 2–5 cm long, borne on 5.0–7.5 cm long, fleshy, pyriform receptacle, called CASHEW-APPLE, with bright-yellow to scarlet skin, soft and juicy, highly aromatic flesh; March–June. *Seed*—145–300/kg; germination 15–50 days, 90–95%; viable for 6–12 months if stored in tins, but lasts 14 months if stored in air-tight containers; needs soaking in water.

Distribution and Ecology—Naturalized and ran wild in warmer parts of India along the seacoast, especially from Orissa to Maharashtra; also very common on the hilly slopes; plantations exist in all coastal states. Thrives well on sandy belts with rainfall ranging from 900 to 3750 mm as on the west coast; grows and yields well in shallow and impervious soils as sandhills where no other economic crop generally grows well; tolerant of saline and clayey soils; grows on red and laterite soils. Heavy rain during monsoon reported to be good.

Silvicultural Characters—Mild, tropical climate most suitable, but sensitive to extremes of temperature. Drought-resistant but less hardy to frost and cold weather. Resistant to strong winds. Blossoms and develops fruits during long, dry periods when other plants do not; needs protection from animals, rodents and birds. If cared for, tree lives up to 70 years; rains during flowering damage crops.

CULTIVATION/ REGENERATION

Artificial Regeneration—Generally propagated from seed, during May–June; vegetative propagation ensures better performance; transplants need careful handling. Nuts with full seeds from regularly and heavily bearing tree are planted in the first rains during May–June; seed sown 2.5 cm deep or sometimes 7.5 cm deep with plumule-end up in 45 cm pits, allowed to weather for 1–2 months, filled with ash and burnt earth; spacing depends upon richness of soil, generally being 4.5–7.5 m but sometimes up to 15 m; 10–12 cm seedlings are transplanted in orchards; stump-planting also gives good results; generally *in-situ* orchards are raised; thinned or gapfilled after one month to 75–300 trees/ha, 200 being the optimum on laterite soils and 125–150 on sandy soils. Air-layering, grafting and budding also yield success. Generally not manured, but if manured, tree becomes vigorous, lives longer and yields better; seldom irrigated; inter-cropped with chillies, ginger, sweetpotato, pineapple, *ragi,* blackgram and even paddy; also tapioca, pepper and cardamom are other choice-crops in

Kerala. Once orchards establish, no further operation is conducted, except protection from cattle; periodical removal of dead wood controls dieback. A few diseases and pests and an algal disease cause damage.

UTILIZATION

Reclamation—Planted for afforestation on barren, denunded areas; coastal saline sands, hilly slopes, clayey, laterite and red soils, a very important tree in agro- and social forestry; grows well under palmyra-groves; closely planted for effective windbreaks for orchards and as soil binders.

Timber—Packing-cases, country-boats.

Fuel—Used as firewood; shell of the fruit also used as fuel.

Others—Bark: Yields tannins (9%); possesses anti-hypertensive and hypoglycaemic properties; milky sap, on exposure, becomes black, useful in indelible ink. Yields a gum with insecticidal properties useful in book-binding and pharmaceutical industry. *Bud & Young Leaf:* Used as vegetable; and also green manure. Leaf contains tannins (23%); used in skin-diseases; alcoholic extract shows hypoglycaemic and anticancer activity. *Fruit:* Delicious and nutritious; kernel eaten (protein, 21.7%; 50% assimilated); also prepared in several ways; yields a highly nutritious oil (40–53%); resinous juice in the seed useful in sexual debility, mental derangement, rheumatic pericarditis and palpitation of heart. Thick thalamus looks like an apple; and juicy, nutritious (ascorbic acid, 150–350 mg/100 g), with pleasant aroma; tender ones acidic, astringent; ripe sweet, slightly astringent; a wine, a brandy and vinegar are produced; syrups, juice, pickles, candy, etc. are also made; used as antiscorbutic and diuretic; given in kidney troubles and cholera.

Shell: Yields an oil (25–30%); used as mosquito larvicide; mild purgative, used in hookworm, cracks on feet, warts, corns and leprous sores; yields also a gum useful for furfural, dulcitol and muric acid; employed in cosmetics, pharmaceuticals, textiles, paper and ink, and possibly in ice-cream; yields a liquid, called cashewnut shell liquid (CNSL), valuable in several industries, such as paints, insulation, adhesive, thermosetting, plastics, cement, lubricants, rubber chemicals, enamels, waterproofing compounds, epoxy-resin, pesticides and drugs. *Seedcoat or -husk:* Yields tannins (24–26%) comparable to that of wattle.

ANDROPOGON Linn. (*Poaceae*)

Annual or perennial grasses; tropical regions; 7spp in India.

A. gayanus Kunth GAMBAGRASS

Habit—A tufted, glaucous, perennial grass, with culms up to 3 m. *Leaf*—glabrous or with short hairs, up to 20 mm wide. *Inflorescence*—spikelets 5–7 mm, pedicelled in 4–10 cm long, paired racemes.

Distribution and Ecology—Introduced into India from Nigeria, grown in India. Grows in low-lying areas with moderate rainfall. Drought- and frost-resistant.

Cultivation/Regeneration—Seeds drilled 15 cm apart in well-prepared beds at the rate of 22 kg/ha.

UTILIZATION

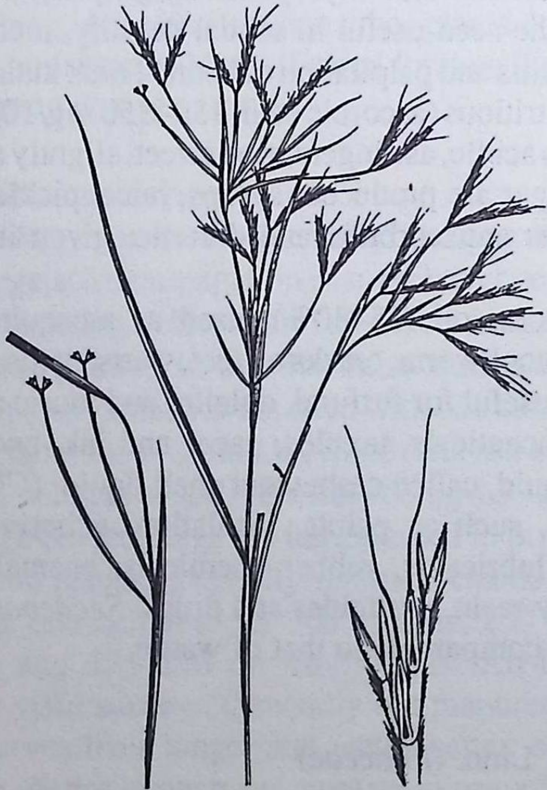
Reclamation—When rotated with other crops, builds up soil-fertility; may be useful as soil-binder. Produces many tillers, particularly during the winter.

Fodder—Good grass (crude protein, 6.9%), remains green during dry months with high yields. Can be converted into hay; grazing-leys provide early fodder at the beginning of rainy season.

Others—Coarse matting, hut-enclosers, sheep-pens, etc.

A. pumilus Roxb.

Guj–*Zinzvo;* Kan–*Chikkanugahullu, neelachallusoppu;* Mar–*Baerki.*



Andropogon pumilus

Habit—A tufted, annual grass, with numerous radiating branches. *Stem*—slender, 15–45 cm, sub-erect, decumbent below. *Leaf*—almost filiform, acuminate, keeled, 7.5–12.5 cm×4 mm. *Inflorescence*—spikes 1.3–1.7 cm in pairs; spikelets sessile, 4 mm.

Distribution—Throughout the drier parts of India from sealevel up to1200 m.

UTILIZATION

Reclamation—Can be grown in drier parts of India for soil-binding.

Fodder—Good protein-rich grass (crude protein, 2.08%), both when fresh and as hay; palatable at all stages of growth, particularly before flowering; when grown pure, produces good leafy matter. Five cuttings yield up to 6 tonnes/ha.

A. hallii Hack., a grass with creeping rhizomes, introduced into India, thriving well; drought-resistant and useful soil-binder. Grass (crude protein, 11.5%) yields a wax.

*ANNONA Linn. (*Annonaceae*)

Woody shrubs and trees; tropical America and Africa; 8 spp and a hybrid in India.

A. cherimola Mill. CHERIMOLA, CHERIMOYA, CHERIMOYAR

Kan–*Hanumaanaphala;* Tel–*Hanumaanaphalamuchettu* (tree), *lakshmanaphalamu* (fruit).

Habit—A shrub or small, straggling, unattractive, deciduous tree, up to 7.5 m. *Leaf*—mostly oval, 13.4 cm × 7.5 cm, pubescent on upper surface, but canescent on the lower. *Flower*—fragrant, green, purple-spotted inside at base-cavity, elongated, pyramidal, 3.1cm × 7.5 mm, with 1.8 cm long pedicel, often solitary or in groups of 2–3, extra-axillary; May–June and July–October. *Fruit*—many berries, aggregated on the pedicel, developing into a light-green, globular or conical, compound syncarp, 5.0–25.0 cm× 7–18 cm, with 10–15 seeds ; December–January. *Seed*—oblong, dark brown, 15 mm × 9 mm, obliquely truncated, smooth; germination after 35–77days; viable for long.

Distribution and Ecology—Probably native to Peru and Equador, introduced and cultivated in South India and Assam. Grows on many types of soils including heavy soils, but flourishes on a fairly rich, aerated soil with moisture. Establishes well on coarse, red and sandy loam and chalky soils in Andhra Pradesh; withstands alkalinity; resists frost more than *A. squamosa* but does not grow where humidity is very high or low.

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* The genus discussed herein is *Annona* Linn. in part

Cultivation/Regeneration—Similar to *A. squamosa,* except for spacing. Propagated from seed, or budding and grafting. Manures and fertilizers help growth. Can be trained; starts bearing at 3rd and 4th year; fruit-setting difficult; beehives or hand-pollination improve fruit-setting. A few pests attack the plant.

UTILIZATION

Reclamation—Can be grown on many types of soils mentioned above.

Others—Fruit: Choicest one for eating raw or baked; pulp fleshy, white or yellow, subacidic with delicate flavour; eaten raw or cooked; cooling-drinks, alcoholic beverages made. *Seed:* Emetic-cathartic; destroys parasites when applied to body. Yields an aromatic, fatty oil (7.8%); on roasting gives the smell of coffee but acts as emetic.

A. glabra Linn. syn. *A. palustris* Linn. ALLIGATOR-APPLE, MONKEY-APPLE, POND-APPLE

Habit—A small tree, somewhat swollen at base, 15 m/1.57 m. *Bark*—pale. *Leaf*—ovate or elliptic, 7–10 cm long, aromatic, leathery. *Flower*—whitish or greenish-yellow, conical, outer petals red-spotted at the inner base; ceases flowering with monsoon. *Fruit*—many berries forming into an aggregate, faintly reticulate, yellow, syncarp, 7–13 cm long. *Seed*—light brown, oval, hard.

Distribution and Ecology—Native to Central America, introduced into India, grown in gardens. Tolerates flooding and grows near water.

UTILIZATION

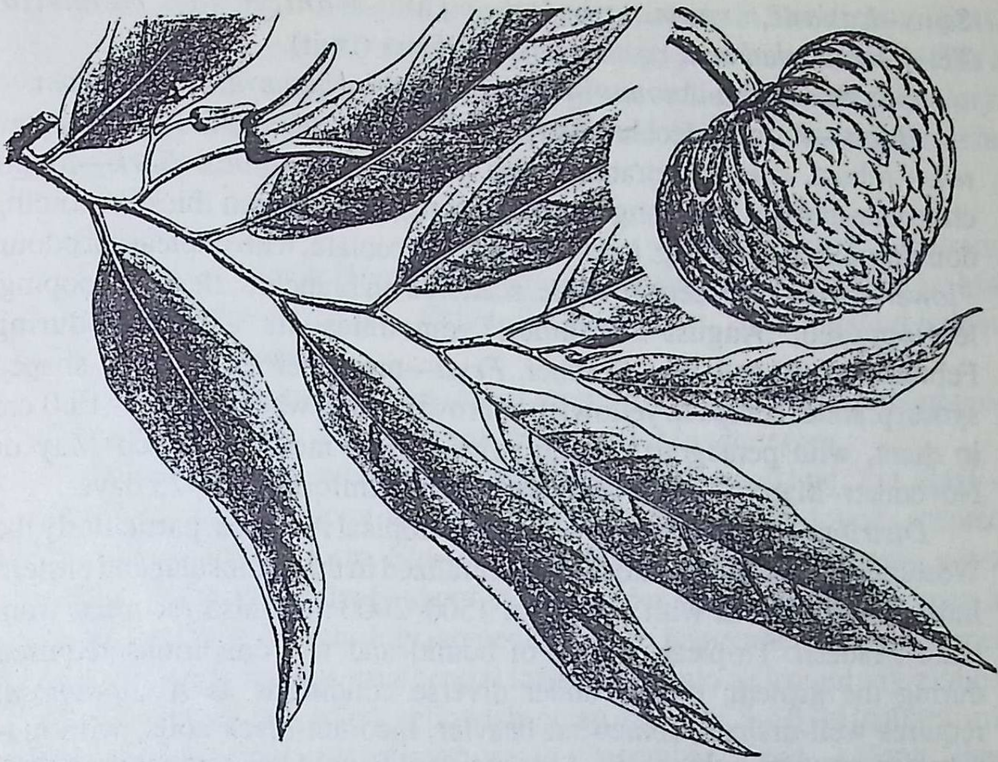
Reclamation—Recommended for growing near swamps, canal- and riverbanks and along with mangroves near salt water.

Timber—Corkwood; and pulp. Ether extract of dried wood and stem-bark contain liriodenine which inhibits carcinoma. *Rootwood*—Can be used for stropping razors and for sharpening the edge of blades.

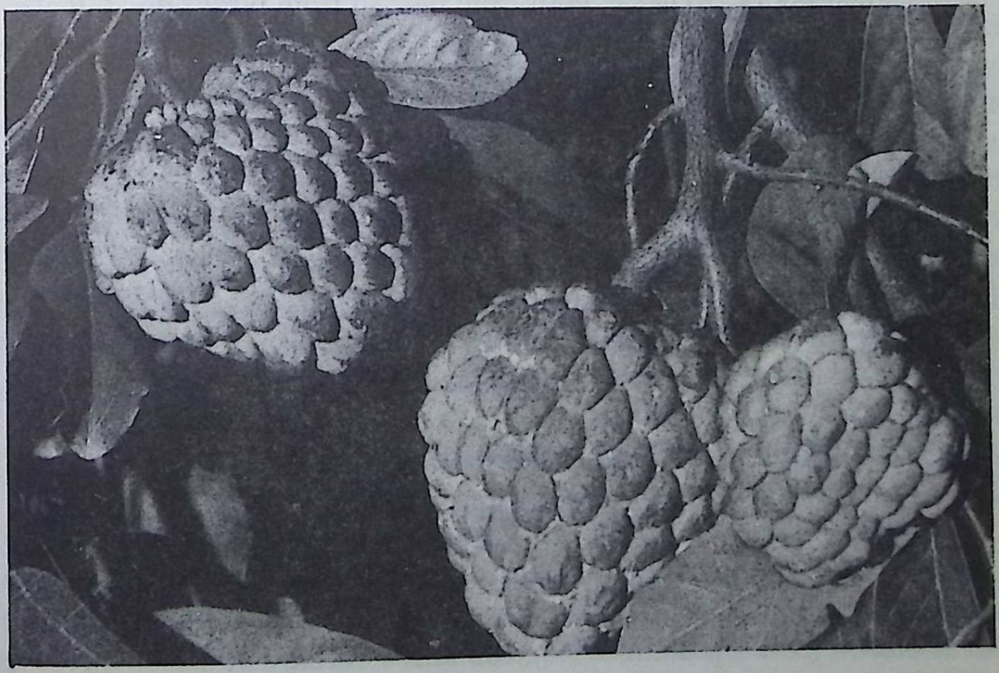
Others—Fruit: Edible. Contains mildly acidic, orange-coloured flesh with orange-like aroma which is improved by boiling; made into a jelly. *Seed:* Toxic; insecticidal.

A. reticulata Linn. BULLOCK'S HEART, THE WEST-INDIAN CUSTARDAPPLE

Beng & Hindi–*Luvuni, nona;* Guj & Mar–*Raamaaphal;* Kan–*Raamaaphala;* Mal–*Raamappazham;* Oriya–*Raamaaphalo;*



Annona reticulata



A. squamosa

Sans–*Lavani*, *raamaaphalam;* Tam–*Manilvatta*, *raamsita;* Tel–*Raamaaphalamu*, *raamaseetaaphalamu* (fruit).

Goa & Konkan–*Anona;* Mundari & Sadri–*Nagneva;* Santal–*Gom.*

Habit—A small, deciduous or semi-deciduous tree, up to 10 m. *Rootsystem*—robust, deep-penetrating, with abundant rootfibres. *Bark*—rough, chocolate-brown, with longitudinal fissures; 1.4–4.0 mm thick, becoming double-quilled on drying. *Leaf*—oblong-lanceolate, with unpleasant odour. *Flower*—solitary, greenish-white, scattered on branches, fleshy, drooping, leaf-opposed; August–December; sometimes in 2 flushes during February–April and July–October. *Fruit*—many berries, in heart-shaped syncarp, solid, compact, yellowish or brownish-red when ripe, 7.5–18.0 cm in diam, with pentagonal aeroles; ripens in 8 months; March–May or November–March. *Seed* —smooth, black; germination 20–25 days.

Distribution and Ecology—Native to tropical America, particularly the West Indies, introduced into India, naturalized in the peninsular and eastern India, up to 1200 m with rainfall of 1500–2000 mm; also recorded from Uttar Pradesh. Tropical climate of humid and wet conditions required during the growth; thrives under diverse conditions as *A. squamosa*; requires well-drained, somewhat heavier, medium-black soils; with manure can grow on lighter soils. Less resistant to cold and temperature than *A. squamosa.*

Silvicultural Characters—Cold and frost affect the plant. Orchards economical for 18–20 years. Protection needed from birds and animals.

Cultivation/Regeneration—Generally as *A. squamosa.* Can be grown as intercrop with *Citrus* spp. Propagated from seed or budding and inarching; 2–3 seeds sown in well-manured and -worked pits of 60 cm^3 at 7.5 m apart; best seedlings retained with 625 /ha; can be raised in nursery and transplanted a year later when 60–75 cm tall; manures and fertilizers improve the crop; irrigation depends upon climate, once in 8–15 days during winter, 5–7 days during summer; margosa-cake (*neem*) can be added to prevent whiteants. Dry- and charcoal-rot and a few pests attack.

UTILIZATION

Reclamation—Can be grown as *A. squamosa.*

Possesses insecticidal properties.

Others—Bark: Powerful astringent. Yields a good fibre; used for cordage. *Shoot:* Yields a blue or black dye. *Leaf:* Anthelmintic, antiphlogistic in tumours. *Root:* Drastic purgative. *Fruit:* Ripe fruit eaten as such or as dessert (edible protein, 7.2%); contains ascorbic acid which increases with ripening. Unripe astringent, anthelmintic, anti-dysenteric, anti-diarrhoeal; given in fever and enlarged spleen; ripe ones in blood-complaints, alleviates biliousness and thirst; stops vomiting; pulp insecticidal; yields a black dye. *Seed:* Astringent, vermifuge; given in diarrhoea and dysentery; yields catechu-like substances. Kernel yields an oil (oil, 42%; crude protein, 14%); toxic to insects.

A. squamosa Linn. CUSTARD- OR, SUGAR-APPLE, SWEETSOP

Beng, Guj, Mar & Hindi–*Seetaaphal, sharifa;* Kan–*Seethaphala;* Mal & Tam–*Seethaapazzham;* Oriya–*Seethaapholo;* Sans–*Seetaaphalam;* Tel–*Seetaaphalamu.*

Assam–*Atakatal;* Konkan–*Ath;* Lambaadi (Deccan)–*Seetaaphalamu;* Mundari–*Bor, daru;* Punjab–*Sharifa;* Santal–*Mandaargom.*

Habit—A large, evergreen, straggling shrub or small tree, 7 m. *Bark*—thin, grey. *Leaf*—oblong-lanceolate or elliptic, pellucid-dotted, scented, 5.0–15.0 cm×1.9–3.8 cm. *Flower*—greenish, fleshy, 1–4, drooping, extra-axillary, more on the leafy shoot than on older wood, tending to open as shoot elongates; March–July, sometimes up to September. *Fruit*—carpels many, lozenge-shaped, on a central torus, fused into an irregularly globose or heart-shaped, tubercled, yellowish-green, syncarp, 5–10 cm in diam; mid August–November, sometimes up to December. *Seed*—oblong, deep brownish-black, aril shining, covered with whitish pulp; 2 cm long; 2800–4500/kg; germination 7–35 days, 80%; viable for 3–7 years; needs soaking for 3 days or scarification.

Distribution and Ecology—Wildly and gregariously growing from the sealevel to hilly tracts, and in various wastelands in Andhra Pradesh; also in Tamil Nadu, Kerala, Punjab, Madhya Pradesh, Uttar Pradesh, Karnataka, Maharashtra, Gujarat, Rajasthan, Bihar, West Bengal and Assam. Prefers warm, dry climate, especially during flowering; very tolerant to many types of soils; poor, shallow soils, granite-gneiss formations with sandy and gravelly soils; in crevices of rocks; light soils are best suited; does well on sandy to medium loam and also on well-drained, red, sandy and gravelly soils in Andhra Pradesh; and pure sandy soils and heavy soils with good drainage which do not crack; tolerates lime and chlorine but not alkalinity.

Silvicultural Characters—Drought-resistant and tolerates temperature up to 40°C. Waterlogging or high watertable causes dieback. Plant enters dormancy from November to December, but neglected trees set stony fruits; pruning helps the development.

CULTIVATION/REGENERATION

Natural Regeneration—Occurs wild, as the seeds, being poisonous, are not eaten and dispersed by birds, animals and humans alike.

Artificial Regeneration—Seeds may be sown fresh or a week-old in flat beds during rains; can be raised *in situ* and thinned later; also transplanting can be done with one-year-old seedlings. Grafting and budding are employed for choice-cultivars for quality fruit. Organic manures and green-manuring and fertilizers are recommended. Mixed cropping with groundnut, pearlmillet, gingelly, *Sorghum*, castor or in coconut plantations as in Kerala, is practised. Spacing of 4–6 m depends upon fertility; closer planting recommended under rainfed conditions or under desert conditions; pits filled with tanksilt and woodash and planted during July–August. Generally, irrigation not needed; but 1–2 irrigations during ripening improve the size and quality. Pruning improves the bushes. A few diseases and pests were recorded on the plant; dieback occurs during heavy rains.

UTILIZATION

Reclamation—Grown on many types of soils, and tolerant to many conditions but does not withstand alkalinity or too much salinity. Can be grown on hilly tracts, rocky areas and wastelands for afforestation and reclamation from sealevel to hills; recommended for agroforestry.

Timber—Cart- and hut-making.

Fuel—Shoots lopped.

Others—Bark: Given in diarrhoea. Extract inhibits potato virus x. Yields bactericidal volatile oil, fibre, and tannin (2.02%). *Leaf:* Anthelmintic, sudorific, insecticidal; crushed ones applied to nostrils in hysteria and fits; poultice kills lice and prevents bedbugs and maggots and issued to extract guineaworms; extracts show adrenaline effect, anticancer and oxytocic activity. Yields an oil (0.08%). *Root:* Diuretic, drastic purgative; employed in depression, spinal diseases, asthma and fever. *Flower:* Eaten; used as pectoral. *Fruit:* Very popular; can be made into jelly, jam, conserves, sherbets, syrup, tarts and fermented drinks. Peelings (0.1%) and pulp (0.02%) yield an oil; can be used for flavouring. Possesses astringent, cooling, antiscorbutic, febrifugal and pectoral properties; reported to enrich blood and improve muscular strength; good for digestion; prescribed in vomiting, diarrhoea, dysentery and vertigo; powdered,unripe fruit used as insecticide. *Seed:* Yields an oil (39.5%), a neutral resin (0.56%) and non-edible protein (19.2%); contains toxic principle which causes blindness; can be destroyed by alkali-refining and such oil can be used for soap-making and as a plasticizer in alkyd manufacture. Refined oil showed encouraging results on edibility; cake can be used as manure; detoxicated cake can be used as feed for cattle and poultry. Possesses insecticidal and piscicidal properties.

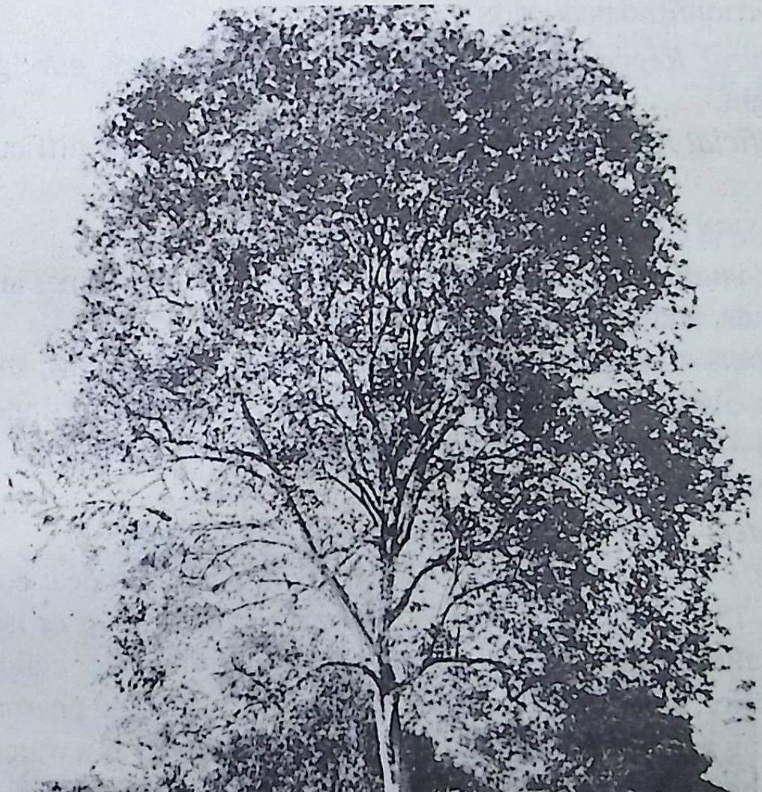
ANOGEISSUS Wall. ex Guill. & Perr. (*Combretaceae*)

Shrubs or trees; tropical Asia and Africa; 5 spp in India.

A. latifolia Wall. ex Bedd. AXLEWOOD, BUTTON-TREE

Guj–*Dhavdo;* Hindi–*Dhaura;* Kan–*Bejjalu;* Mal–*Marukanjiram;* Mar–*Dabria;* Oriya–*Dohu;* Tam–*Vekaynaga;* Tel–*Chirumaanu, tellamaddi.* Bihar–*Bhanji;* Uttar Pradesh, N-W Himal–*Bakli.*

Habit—A small to fairly large tree, up to 33 m/2.4 m. *Stem*—deeply fluted towards base, clear bole 4–12 m. *Bark*—pale yellowish or pinkish-brown, spotted with greenish depressions, exfoliating in round flakes leaving shallow depressions. *Leaf*—elliptic-obtuse, entire, reddish to green, turning reddish, 5–7cm long. *Flower*—minute, greenish-yellow, in globose heads; June–September. *Fruit*—yellowish-brown to reddish-brown, small, winged, 1-seeded. *Seed*—wedge-shaped; 34,000–135,800/kg;



Anogeissus latifolia

December–May; best period for collection when heads start breaking; best results from seed collected after dry years; germination 20 days, 0–12%; dried and stored in tins.

Distribution and Ecology—Forests of sub-Himalayas, Siwaliks, and other hills throughout India, up to 1200 m; also in dry deciduous forests; abundant in Bihar, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra, and in Rajasthan. Best on alluvial soils; avoids swampy and waterlogged soils, and very dry areas; suitable for dry, rocky hills and ravines; grows on sandstone, limestone, metamorphic rock-trap and laterite. Generally stunted and gnarled on the dry hillslopes.

Silvicultural Characters—A light-demander, though seedlings tolerate some shade. Fairly drought- and fire-resistant; and generally frost-hardy; possesses great power of recovery. Produces rootsuckers. Coppices and pollards best during winter. Growth moderate.

CULTIVATION/REGENERATION

Natural Regeneration—Generally poor, but best during the years of drought.

Artificial Regeneration—Transplanted without any difficulty.

UTILIZATION

Reclamation—Can be grown on dry, rocky hills, ravines and denuded wastelands, and in dry regions.

Timber—Construction, furniture, implements, bobbins, shuttles, plywood, insulating material; and for paper-pulp. Can be substituted for teak.

Fuel—Excellent for firewood and charcoal (sapwood, 4986 kcal; heartwood, 4909 kcal/kg).

Fodder—Leaf lopped (crude protein, 8.1–11.5%).

Others—Bark: Astringent; useful in chronic diarrhoea; contains tannins (12–18%). Exudes a gum in dry years, called *ghatti* or INDIAN GUM; used in calico-printing, confectionery; given as tonic after childbirth; used as emulsifier, stabilizer, thickener, in ceramics, food and pharmaceuticals, hair-setting agent, drilling-mud conditioners and used as a water-desiccant in explosives. *Leaf:* Yields tannins (young, 5.0%; mature, 32%), known as INDIAN SUMAC; used in tanning leather.

A. pendula Edgew.

Guj–*Dhaw, dhanukra;* Mar–*Kardahi.*
Uttar Pradesh, Rajasthan–*Dhanukra.*

Habit—A bush or tree, 9–15 m/1 m. *Bark*—smooth, grey, often silvery. *Leaf*—small, reddish when fruiting, elliptic-obovate, silk-hairy. *Flower*—in heads, on slender peduncles; at the end of rainy season in September. *Fruit*—small, winged, orbicular, 1-seeded; 96,400–100,000/kg; December–March. *Seed*—germination 7–15 days, 2–9%; December collection with poor germination and February collection with better germination; drought before flowering and fruiting stimulates production of fertile seeds; stored in air-tight containers.

Distribution and Ecology—Limited to the Aravalli hills in Rajasthan, especially Ajmer–Marwar forests, to Bundelkhand, Jhansi, Hamirpur and Banda Districts of Uttar Pradesh and Madhya Pradesh; planted for ornament. Inhabits dry, hot regions (350–950 mm) and a remarkable species of Aravalli, in dry deciduous, low and mixed xeromphic thorny forests.

Silvicultural Characters—A light-demander. Generally drought- and fire-resistant; frost-hardy; possesses great power of recovery. Produces rootsuckers particularly on reddish loam with more gravel. Coppices on degraded land and pollards well. Should be protected from grazing. Growth slow.

CULTIVATION/REGENERATION

Natural Regeneration—Not adequate as the germination is poor; also regenerates through root-suckers.

Artifical Regeneration—Nurserybed should be prepared with farmyard manure; sown (60 g seed/1m) from February to June; regularly irrigated; 2–3-year-old seedlings are preferred to direct sowing; 2-year-old stumps fare better than transplanting; planting should be on ridges.

UTILIZATION

Reclamation—Suitable for semi-rocky and rocky places of arid regions and on gentle slopes extending to the top of hillocks and ridges if soil is good.

Timber—Furniture, agricultural implements, handles, poles, shuttles, bobbins; shafts; and for huts; recommended as a substitute for teak.

Fuel—Moderate firewood (sapwood, 4837 kcal; heartwood, 4739kcal/kg)

Fodder—Leaf good fodder (crude protein, 7.6%).

Others—*Bark:* Yields a gum called *ghatti* or INDIAN GUM. *Leaf:* Yields tannins, widely used for tanning sheepskin in Rajasthan and Madhya Pradesh.

A. rotundifolia Blatt. & Hall. (Rajasthan–*Dhauro, indoko*) is a medium-sized tree, *c* 6 m in height, endemic to Rajasthan; grows on sandstone, rocky, semi-rocky and gravelly soils and on mineral soils.

APLUDA Linn. (*Poaceae*)

Annual or perennial grasses; South-East Asia to Australia; 1sp in India.

A. mutica Linn. syn. *A. aristata* Linn.; *A.varia* Hack.

Beng–*Goroma;* Hindi–*Ponai;* Kan–*Akkuhullu;* Tam–*Mandapilluv;* Tel–*Putstryagaddi.*

Bombay–*Khavas;* Madhya Pradesh–*Kadmor;* Uttar Pradesh–*Bhanjura.*

Habit—A variable grass, usually erect, often assuming a climbing habit in hedges and bushes. *Culm*—solid, up to 2.5 m. *Leaf*—linear-lanceolate, 10–35 cm long. *Inflorescence*—dilated, spathe-like panicle.

Distribution and Ecology—All over the plains and hills of India, up to 2100 m, in Rajasthan desert, hills, rocky outcrops, gullies and on clay-loam and clayey soils, and ravines.

UTILIZATION

Reclamation—Suitable for desert, hills, rocky outcrops, gullies, ravines as groundcover; also suitable for dry deciduous low forests.

Fodder—Used as green fodder; also mixed with hay (crude protein, 10.25%).

Others—Stalk: Used for hats; good raw material for rayon industry (cellulose, 50%).

ARISTIDA Linn. (*Poaceae*)

Slender, annual or perennial grasses: temperate, subtropical and tropical regions; 12 spp in India.

Found in open, dry situations and even on poor, shallow soils in the drier regions. Some species build up hydrocyanic acid in their tissues.

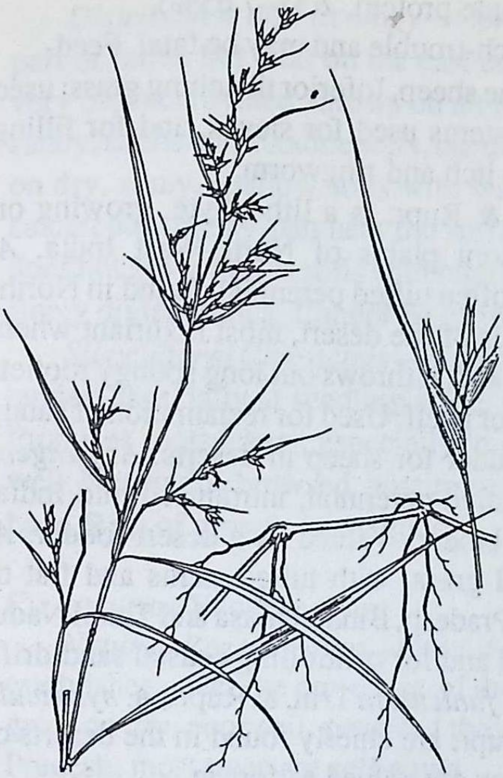
A. depressa Retz., non Hook. f. & Thoms. syn. *A. adscensionis* Hook. f. (Fl Br Ind) in part, non Linn.; *A. redacta* Hook. f. (Fl Br Ind) in part, non Stapf

Habit—A densely tufted annual or perennial. *Stem*—culm very slender, erect, simple or branched. *Leaf*—8–30 cm long, convolute, filiform. *Inflorescence*—contracted, subsecund panicle, 8–30 cm long.

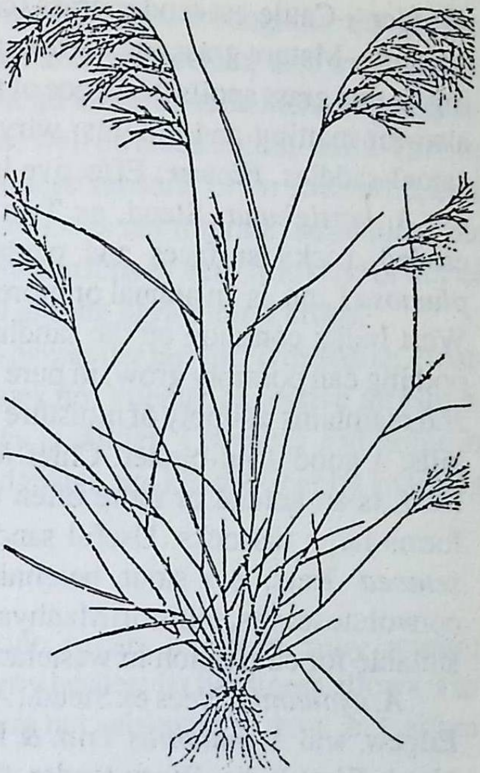
Distribution and Ecology—Throughout India in the plains and low hills, up to 2400 m in Kashmir. Forms a dense community on sand-dunes. Drought-resistant.

UTILIZATION

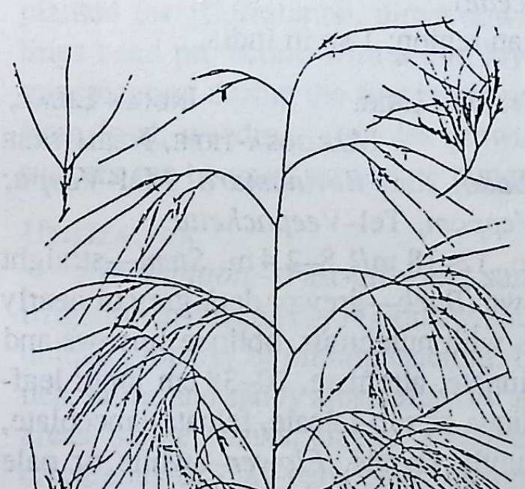
Reclamation—Can be grown as a stabilizer of sand-dunes. Forms dense community with *Indigofera cordifolia* and effectively controls erosion.



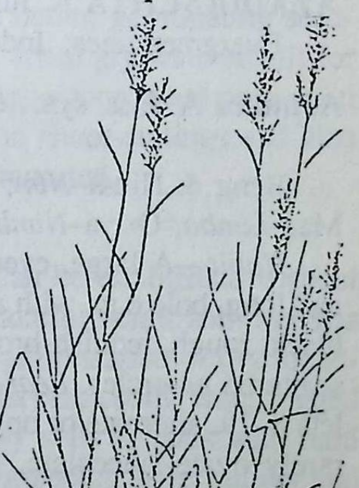
Apluda mutica



Aristida depressa



A. cyanantha



A. mutabilis

Fodder—Cattle eat tender grass (crude protein, 2.31–7.65%).
Others—Mature grass causes stomach-trouble and may be fatal. Feeding on this grass spoils the fleece of the sheep. Inferior thatching grass; used also for matting and brooms; wiry stems used for sieves, and for filling camel-saddles. *Flower:* Effective in itch and ringworm.

A. hertigluma Steud. ex Trin. & Rupr. is a lithophyte, growing on eroded, rocky surfaces and piedmont plains of North-West India. *A. plumosa* Linn. is an annual or more often tufted perennial, found in North-West India; common on the sandhills of the desert, most luxuriant where nothing can possibly grow; in pure sand, it throws out long spongy rootlets and maintains a supply of moisture for itself. Used for reclamation of sandy hills; a good sand-binder. Chief fodder for sheep in deserts. *A. pungens* Desf. is an annual or more often tufted perennial, introduced into India; forms large tussocks. Useful sand-binder. Valued as a desert-fodder. *A. setacea* Retz. is a stout, perennial grass, with tufted stems and flat or convolute leaves, found in Madhya Pradesh, Bihar, Orissa and Tamil Nadu, suitable for cultivation in wasteland and for controlling coastal sand-drift.

A. cyanantha Nees ex Steud., *A. funiculata* Trin. & Rupr., *A. hystricula* Edgew. and *A. mutabilis* Trin. & Rupr. are chiefly found in the deserts of North-West India. When tender, they are valued as forage.

AZADIRACHTA A. Juss. (*Meliaceae*)

Evergreen trees; Indo-Malaysian region; 1 sp in India.

A. indica A. Juss. syn. *Melia azadirachta* Linn. INDIAN LILAC, MARGOSA-TREE, NEEM-TREE

Beng & Hindi–*Nim;* Guj–*Limbado;* Kan–*Bevinamara;* Mal–*Veppa;* Mar–*Limba;* Oriya–*Nimba;* Tam–*Veppam;* Tel–*Veepachettu.*

Habit—A large, evergreen tree, 12–18 m/1.8–2.4 m. *Stem*—straight and long, bole 6 m, with a large crown. *Bark*—grey or dark grey or nearly black, rough, reddish-brown inside, with numerous, oblique furrows and scattered tubercles. *Leaf*—imparipinnate, alternate, 20–38 cm long: leaflets 8–19, alternate or opposite, oblique or sub-falcate, falcate-lanceolate, rarely ovate-lanceolate, glossy, bluntly serrate. *Flower*—white or pale yellow, generally small, honey-scented, numerous, in slender, lax, axillary panicles; January–March, but varies according to local climate, sometimes as late as August–September. *Fruit*—green, turning yellow on ripening, aromatic, oblong, ovoid-oblong, smooth drupe, 1.3–1.8 cm long. *Seed*—depends upon flowering, as flowering varies from one climatic zone to the other; 3300–6300/kg; germination 7–21days, 100%; no dormancy and does not retain viability for long; can be stored at room temperature.

Distribution and Ecology—Commonly found throughout the greater part of India, but wild on the east coast and the Deccan; also in Siwaliks; very often cultivated. Grows on almost all kinds of soils including clayey, sandy, saline and alkaline soils, but does well on black cotton- soils. Thrives on dry, stony, shallow soils with waterless subsoils or on soils with hard calcareous or clay-pan near the surface. Does not tolerate inundation; but does not grow well in soils with high proportions of very fine sand or silt or finely divided mica. Cannot be grown among agricultural crops.

Silvicultural Characters—A light-demander but survives shade. Frost-tender, especially at seedling stage; does not tolerate excessive moisture. Produces rootsuckers, especially in dry localities. Coppices and pollards well. Not readily browsed; porcupines damage and kill the trees by gnawing bark. Rate of growth fairly good.

CULTIVATION/REGENERATION

Natural Regeneration—Germination occurs freely in rainy season; establishes under the protection of thorny bushes; its hardiness allows it to grow on dry, poor soil, provided they are not subjected to frost. In Andhra Pradesh, most trees are self-sown.

Artificial Regeneration—Though easily raised in nursery and transplanted for afforestation, direct sowings prove better; germinating seedlings need protection with a thin layer of soil, sparingly watered; fit for transplanting during the first rains; pruning may be done; need protection from frost; weeding promotes growth; root- and shoot-cuttings and also suckers can be used; no serious fungus or pest reported.

UTILIZATION

Reclamation—Fast-growing, sturdy tree. Can be established without irrigation in hot and dry regions. Planted for reclaiming acidic soils as it has unique property of mining calcium. Useful for afforestation of dry localities, saline and sandy areas, shallow alluvial soils, black soils, waterlogged areas, saline blanks, clayey, alkaline, dry, stony soils or soils with hard calcareous or clay-pans near the surface, for greening bare gullies and ravines and for checking soil-erosion in degraded non-forest-plantation lands, in grasslands, etc.; used for agroforestry. Increases soil-fertility and water-holding capacity; useful roadside tree with excellent shade during summer; grown as windbreaks.

Timber—Pest-proof. Furniture, agricultural implements, boards, pencils, oilmills, small articles, images, toys, and drums. Suitable for small bridges.

Fodder—Camels eat the shoots; given with other feeds to cattle (leaf: crude protein, 7.1%). Increases secretion of milk after parturition.

Others—Medicinal: Every part is utilized, most important being the fruit. Extracts antidiabetic, antibacterial and antiviral and successfully used for stomachworms and ulcers.

Bark: Astringent, beneficial in malarial fever and useful in cutaneous diseases. Contains nimbin (0.04%), nimbinin (0.002%) and nimbidin (0.4%). Yields as essential oil (0.02%) similar to that of flower; and tannins (12–16%): used for goatskins; yields a red dye. Also yields a gum (EAST-INDIA GUM); stimulant, demulcent, tonic; useful in catarrhal and other affections; substituted for gum arabic and used by silk-dyers in colours. A fibre is obtained for ropes; *Rootbark:* Also used as astringent, tonic and antiperiodic.

Leaf: Carminative; with *Piper nigrum* is effective antihelminthic; along with *Psoralea corylifolia* Linn. and *Cicer arietinum* Linn. is an effective medicine in leucoderma; extract possesses antiviral, antidiabetic and antibacterial properties; delays clotting of blood; hot infusion given for fomenting swollen glands, bruises and sprains. Yields an essential oil (0.13%). Used as insect-repellant in clothes, grain and as nematocide, and as manure and mulch.

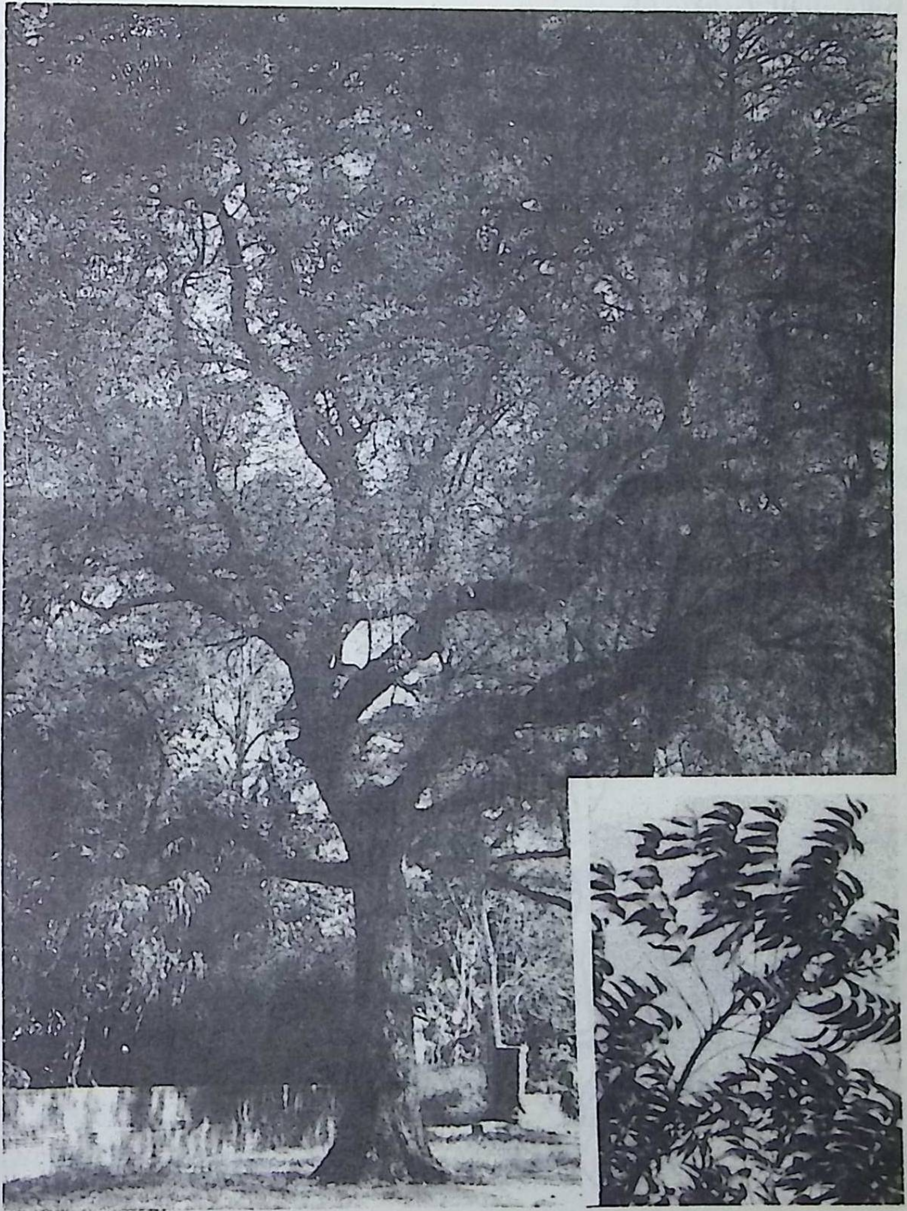
Flower: Eaten raw or in curries and soups, or fried; useful in atonic dyspepsia and general debility. Yields a nectar and an oil (0.025%).

Fruit: Pulp eaten by humans and animals. Astringent, toxic, antiperiodic, purgative, emollient, anthelmintic; pulp-water can be used as insecticide and manure.

Seed & Oil: Powdered kernel is mixed with grains to repel insects without any adverse effect. Kernel yields a bitter, acrid, fixed oil (40.0–48.9%), OIL-OF-MARGOSA, with garlic-like smell; used as illuminant; can be refined. Used for skin-diseases, ulcers, rheumatism, sprains, leprosy, in urinary problems, earache, tooth-troubles, asthma; possesses antifertility, antifungal and antiseptic properties. Ideal contraceptive for human beings. Used in cosmetic preparations, such as soaps and pastes, mixed with hair-oil to prevent baldness, employed in insecticidal sprays. Oil yields nimbidin (1.2–1.6%), a potentially antiulcer and anti-inflammatory compound, nimbin (0.1%) and nimbinin (0.01%); sodium nimbidinate obtained from nimbidin has potent diuretic and antinflammatory properties. Nimbidin is toxic to frogs and parasitic nematodes and inhibits fungi; nimbin is non irritant and antipyretic and recommended in high-grade paracosmetics. Also, oil yields nimbidol; both possess anti-arthritic action. Oil can be converted into polyol, a substitute for rocket-fuel. Can be used in textile, leather and rubber industry; oil-coating to urea regulates nitrification.

Seedcake: Rich food (carbohydrates, 26.1%; crude protein, 36%); used as manure; more useful for sugarcane, cotton and paddy; also inhibits nitrification; possesses insecticidal and nematicidal properties. Processed cake good for poultry.

Shell: Used for toothpowder and activated carbon, fuel, and for briquettes and handboards.



Azadirachta indica

BALANITES Delile (*Balanitaceae)*

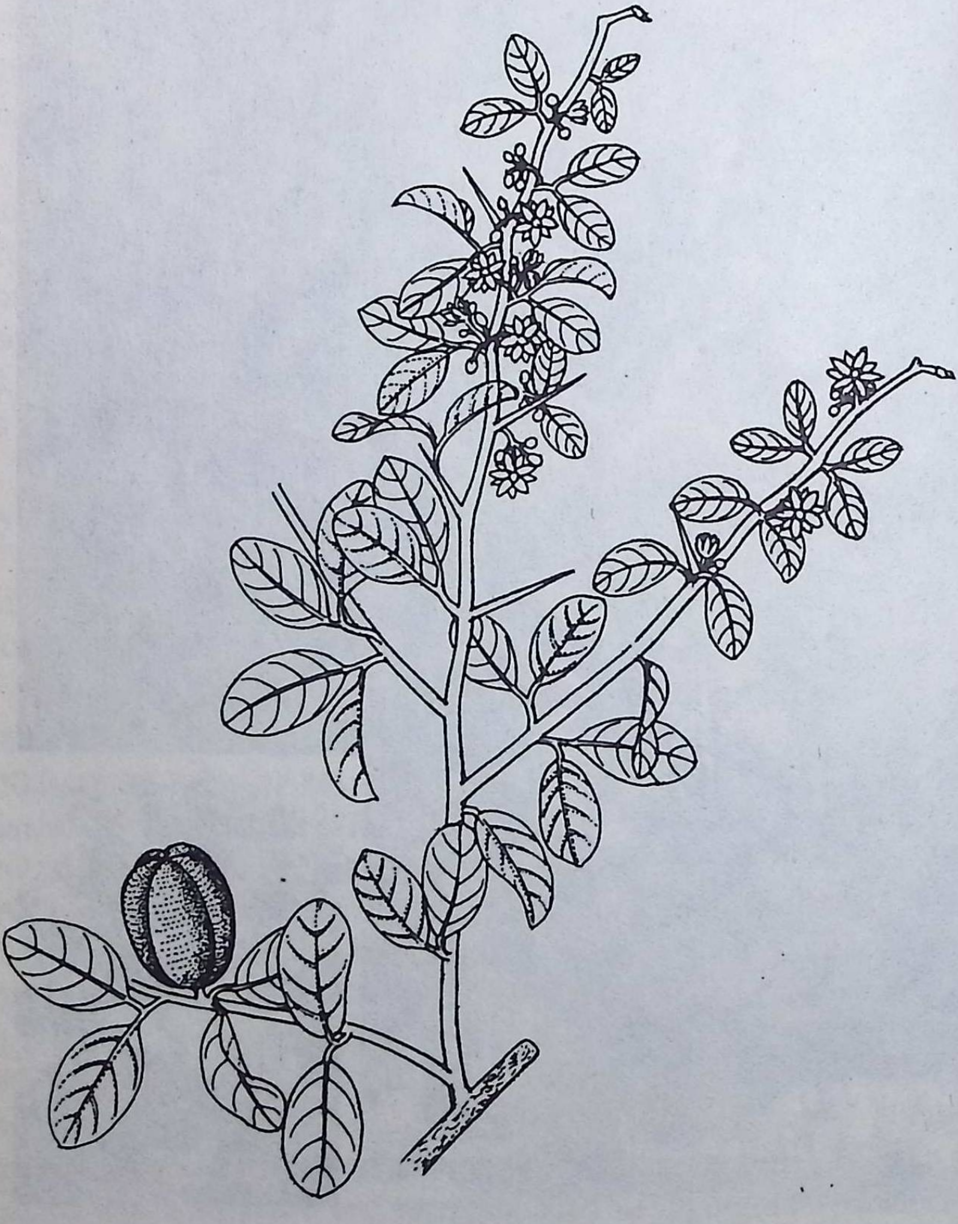
Thorny shrubs or small trees; Africa to Burma; 1 sp in India.

B. roxburghii Planch. syn. *B. aegyptiaca* (Linn.) Delile var. *roxburghii* Duthie DESERT-DATE

Beng–*Hingol;* Guj–*Ingoriyo;* Hindi & Mar–*Hingan;* Kan–*Ingalore;* Mal–*Nanjunta;* Oriya–*Ingudihala;* Sans–*Angavruksha;* Tam–*Nanjundan;* Tel–*Gara.*

Rajasthan–*Hingorni.*

Habit—A spiny, evergreen tree, up to 9 m. *Bark*—grey, 6 mm thick.



Balanites roxburghii

Leaf—bifoliolate: leaflets elliptic or obovate. *Flower*—small, greenish-white, fragrant; April–May. *Fruit*—woody, ovoid, 5-grooved drupe, 2.5–6.0 cm long, enclosing an oily seed in bitter pulp; October.

Distribution and Ecology—In drier parts of peninsular India, from western Rajasthan and South-East Punjab to West Bengal and Sikkim. Common in open sandy plains, older alluvial and mineral soils and ravines; forms understorey of dry, deciduous, low forests. Drought-hardy.

Cultivation/Regeneration—Through direct sowing, transplanting, or rootsuckers.

UTILIZATION

Reclamation—Can be grown to reclaim the soils mentioned above and to prevent erosion; also can be grown on waterlogged areas. In Rajasthan, used as shelterbelts, windbreaks and hedges. Produces large biomass.

Timber—Walking-sticks and handles.

Fuel—Yields firewood.

Fodder—Leaf, though acrid, eaten by cattle, sheep and goats. Seedmeal may be used as cattle-feed (protein, 56.4%).

Others—*Bark:* Anthelmintic, spasmolytic, fish-poison. *Leaf:* Anthelmintic. *Root:* Emetic, contains diosgenin (0.2–2.2%). Used as fish-stupefying material. *Fruit:* Pulp sweet, acidic and edible; useful in whooping-cough and skin-diseases; used as anthelmintic; possesses spermicidal activity. Contains diosgenin (0.3–3.8%). Removes stains on silk- and cotton-clothes. Excellent corrosion-inhibitor for brass and aluminium alloys. Adulterated with myrobalans. *Seed:* Powder given in typhoid. *Kernel:* Yields an oil (36–43%); possesses anthelmintic, antibacterial and antifungal activity; used in skin-diseases, burns and in soaps.

BAMBOOS (*Poaceae*)

Undershrubs to tall, perennial, arborescent grasses; humid tropical, subtropical and mild-temperate regions, mostly being in the tropics of the Old World; majority inhabit South-East Asia; 150 spp in India, many being introduced. Dwarf species cultivated for ornament in pots and trays.

About 20 genera are important: *Arundinaria* Michx. *sensu stricto*, *Bambusa* Schreb., *Cephalostachyum* Munro, *Chimonobambusa* Makino, *Dendrocalamus* Nees, *Dinochloa* Buese, *Gigantochloa* Kurz, *Indocalamus* Nakai, **Melocalamus* Benth., *Neohouzeaua* Gamble, *Ochlandra* Thw., *Oxytenanthera* Munro, *Phyllostachys* Sieb. & Zucc., *Pseudostachyum*

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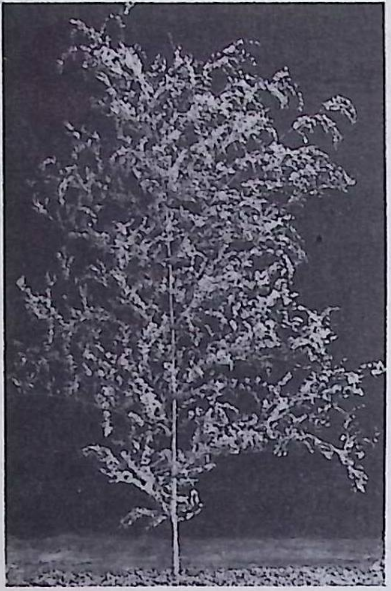
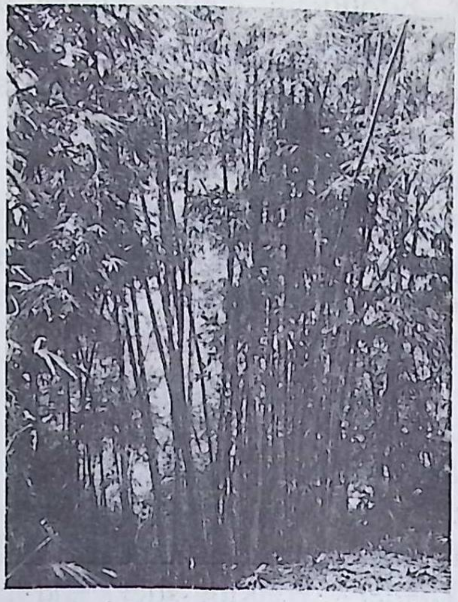
* The Indian species of *Melocalamus* are referred to a new genus *Neochloa* by some authors.



B. nutans



B. tulda

B. polymorpha

Munro, *Schizostachyum* Nees, *Semiarundinaria* Makino ex Nakai, *Sinobambusa* Makino, *Teinostachyum* Munro and *Thamnocalamus* Munro. Besides these, *Sasa* Makino & Shibata and *Thyrsostachyus* Gamble have been introduced for cultivation.

Habit—Lofty forms of 37 m as in *Dendrocalamus giganteus* Munro in tropical regions to mere undershrubs of *c* 50 cm as in some *Arundinaria* spp at higher altitudes; mostly tall and erect but some slender and scandent climbers, and a few creepers; characterized by woody, pointed stems, arising from the underground woody, jointed rhizomes, called 'culms', may be single-stemmed as in *Melocanna* Trin. and *Phyllostachys* or clump-forming as in *Bambusa* and *Dendrocalamus;* intermediate types also are found. May be divided into two groups: (*i*) running–rhizomes laterally spread to long distance and produce a culm at intervals; and (*ii*) clump-forming–short rhizomes and shoots produced each year result in the formation of clumps.

Culm generally round, smooth, condensed with bulges as in *Bambusa ventricosa* McClure; usually hollow (THE FEMALE BAMBOOS), separated with septa at nodes; also solid as in *D. strictus* (Roxb.) Nees and *Oxytenanthera stocksii* Munro (THE MALE BAMBOOS); diameter varies from a few millimetres to more than 30 cm; mostly green when fresh, but sometimes beautifully golden-coloured with green stripes as in *B. vulgaris* Schard. ex Wendl., non Nees or variously variegated; also near black as in *Gigantochloa atter* Kurz ex Munro; ordinarily do not bear any branches to a considerable height, but in some either devoid of branches to a considerable height or have only very small branchlets; *B. nutans* Wall. ex Munro and *D. hamiltonii* Nees & Arn. ex Munro possess prominent branches; *B. arundinacea* (Retz.) Roxb.; Gamble (Fl Br Ind) in part and *B. tulda* Roxb. have dense clusters of branchlets at nodes, almost alternately arranged; branchlets thorny in *B. arundinacea*, bearing false rootlets at the lower nodes which harden into spine-like structures forming a natural armour to the clumps. Many species produce aerial roots at the nodes. New culms rapidly grow during rains, attaining full height in 2–4 months; generally grow *c* 7.5 cm/day, but recorded up to 1 m in *D. giganteus*. Many gigantic species produce 10–20 culms a year; some of the shrubby species produce 50–100 or even more. Average life of the culm 7–10 years.

Many species gregariously flower and seed once and die soon after; vegetative state and incidence of flowering vary from species to species; many have an almost sharply defined flowering-cycle of 1,3,7,11,15,30,48 and 60, possibly even 120 years, at the end of which all plants from the same

DISTRIBUTION, SOIL AND SITE - FEATURES OF SOME BAMBOOS IN INDIA

Species	Nature of soil	Suitability	Moisture status	Distribution
Arundinaria racemosa Munro	Rich sandy loam to clayey loam, often mixed with stones	Hillslopes and high terraces	Moist situation	Eastern Himalayas; at 2200–3050 m.
Bambusa arundinacea (Retz.) Roxb.; Gamble (Fl Br Ind) in part	Flat alluvial and rich moist soil; prefers moderately fine clayey soils and tolerates slight waterlogging; avoids coarse-grained soils and open ridges	Flourishes best along the river-banks, in valleys and ravines	Moist localities	All over the country except in the dry regions and desert areas; mostly in the Indian Peninsula; cultivated in sub-Himalayan tract and Indo-Gangetic plains; scarce in Assam and West Bengal.
B. polymorpha Munro	Flourishes best on deep, fertile and well-drained loam and riverain alluvium	Lower hillslopes and along the valleys; avoids steep precipitous slopes	Moist localities	West Bengal, Assam, Kerala, Tamil Nadu; prefers tropical evergreen or semi-evergreen type of climate.
B. tulda Roxb.	Alluvial soils along water-courses	Flat land	Prefers moist area	Hilltracts of Assam, West Bengal, Central India and Deccan Plateau; in moist mixed deciduous forests.
Cephalostachyum pergracile Munro	Well-drained, fresh loam	Low-hill country	Between dry and moist site	Assam, Central India and Deccan Plateau; in dry and moist deciduous forests.
Chimonobambusa falcata (Nees) Nakai syn. *Arundinaria falcata* Nees	Rich, sandy loam to clayey loam, often mixed with stones	Hillslopes and high terraces	Moist situation	Western Himalayas, at 1300–2200 m.
Dendrocalamus brandisii Kurz	Black loam and loam with lateritic nodules and other good soils	Along the rivers	Moist localities	Kerala, Karnataka and Tamil Nadu; in moist, west-coast climate.

D. hamiltonii Nees & Arn. ex Munro	Rich, loamy soil	Valleys and along streams	Moist places	Central and eastern Himalayas; up to 1000 m; in moist deciduous and semi-evergreen forest.
D.longispathus (Kurz) Kurz	Fertile loam	Mostly along streams	Moist areas	West Bengal, Assam, Kerala and Tamil Nadu; as an associate of moist, mixed forests.
D. strictus (Roxb.) Nees	Poor, coarse-grained, well-drained, dry soils and stony soils on hill-sides; avoids poorly drained and moist, heavy-clay soils	Hillslopes, alluvial plains and ravines	Dry areas	Most widely distributed all over the country except northern parts of West Bengal, Assam and other very moist areas; occurs in dry, open-type deciduous forests; common associate of dry *sal* and dry teak forests. Also occurs on hills up to 1000 m.
Indocalamus wightianus (Nees) Nakai syn. *A.wightiana* Nees	Fertile loam	High hills	Moist situation	Evergreen sholas of southern India especially the Nilgiris.
Melocanna baccifera (Roxb). Kurz syn. *M. bambusoides* Trin.	Fertile loam	Hillslopes and abandoned clearing by shifting cultivation	Moist areas	Moist and wet hilltracts of West Bengal, Assam and other parts of country.
Ochlandra travancorica (Bedd.) Benth. ex Gamble	Rich, loamy soils	Banks of perennial or semi-perennial streams, lower slopes and flat lands	Moist areas; prefers running water	Western ghats; as under-growth in evergreen and semievergreen forests up to 1600 m.
Oxytenanthera ritcheyi Blatter & McCann syn. *O.monostigma* Bedd.	Shallow, rocky soils	Hilltops and ridges	Dry areas	Western ghats and hills of Indian Peninsula; as under-growth in mixed deciduous forests.
O. nigrociliata Munro	Fertile loam	Along streams and slips	Moist areas	Orissa, Assam, Central India and Deccan Plateau; gregarious in semi-deciduous forests of Andaman and Nicobar islands.

seed gregariously flower; and also occurs in waves over 3–4 years. Inflorescences range from a few spikelets to gigantic panicles and fruits range from the size of paddy to 12.5 cm; some exhibit vivipary.

Distribution and Ecology—Found as an understorey in many types of forests in almost all the states, forming important constituent of many deciduous and evergreen forests from sealevel and flat alluvial plains to high mountains, up to 4000 m, except in Jammu and Kashmir where they are cultivated. More than half the number of species of bamboos occur in Sikkim, West Bengal, Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura and Meghalaya. Other important regions are the Andaman and Nicobar Islands, Bastar in Madhya Pradesh, Andhra Pradesh, Orissa and western ghats; a few are found in other parts of India, both on the hills and in the plains.

Bamboos are drought- and frost-hardy, but the extent to which they flourish depends upon the physical nature of the soil including the depth, texture, moisture-content and fertility. Most of the bamboo-soils have a good reserve of sesquioxides and potassium, but deficient in calcium, magnesium and phosphorus. They grow on a variety of soils, provided well-drained and not waterlogged. They thrive on various geological formations, such as the Deccan-Traps, sandstones, conglomerates, quartzites, schists and gneisses.

Many bamboos occur on sandy loam to loamy-clay soils. Though may prefer a well-drained soil, some *Ochlandra* spp and *B. arundinacea* can withstand or prefer extremely wet, swampy areas. Bamboos are found on clay or black cotton-soils. However, they do not grow on saline and alkaline soils, and shallow, stiff and heavy clays. Individual species are known to prefer well-defined conditions of soils and can fairly reliably indicate the quality of site (Table). *Arundinaria* spp and *Pseudostachyum* spp indicate moist soils of cold sub-Himalayan region. *D. strictus* can grow on any well-drained soil, but is most luxuriant on porous, coarse-grained soils with low moisture-retaining capacity, and on well-drained sandy loam overlying boulders on hillsides. *B. arundinacea* also grows on all types of soils, having adequate moisture, but prefers moderately heavy soils; mostly confined to the streambanks and low-lying and flat, moist areas. *Ochlandra travancorica* (Bedd.) Benth. ex Gamble is similar to *B. arundinacea*, but prefers running water and areas with heavy rainfall. *B. arundinacea* and *D. strictus* have been reported to grow on soils having a *p*H of 4.7–6.0 and 5.5–7.6, respectively.

CULTIVATION/REGENERATION

Bamboos need warm temperature, though a range from –5° to 46°C is suitable for successful growth and cultivation, and require a rainfall of 75–500 cm or more. Nearly 60 species are cultivated in India from sealevel to 4000 m, *D. strictus* being the most common bamboo cultivated up to 2000 m.

Natural Regeneration—Bamboos regenerate from seeds with ease. Gregarious flowering results in numerous fertile seeds, and these profusely germinate with the onset of monsoon. Although weeds and shade heavily affect regeneration, many seedlings survive and gradually form individual clumps in favourable localities, usually in open patches. Natural thinning also occurs. In about six years or so, a homogeneous crop of almost equally spread, young clumps is formed. Fire and grazing are hazardous to natural regeneration, the former being less disastrous. Heavy grazing by herds of deer, elephants, bisons, pigs and cattle is responsible for considerable damage to the crop and protection is necessary.

Artificial Regeneration—Through seeds, divisions, offsets, marcotting, stem- or rhizome-cuttings or by layers and ready for exploitation in 10–12 years. Seedlings also can be transplanted, but seeding-years are scarce. Hence, generally regenerated through vegetative propagation. Field is cleared and fenced before monsoon. Bamboos are planted both in pits (60 cm × 30 cm×30 cm) and contour trenches at 3 m× 3 m, depending upon the slope. On slopes, it is recommended to stagger the pits. In low-rainfall areas, they are planted in sunken pits for conservation of moisture.

Though plantations generally not given fertilizer, ammonium sulphate or calcium-ammonium nitrate (200 g) and superphosphate (200 g per plant), if applied at the time of planting, promote better development of roots; a similar dose is also recommended in the second year in July. Combination of biofertilizer (Azotobacter) and inorganic fertilizer yields significant height. About 3–5 weedings, and hoeing around plants, earthing up, and mulching are done during the first three years of planting. Protection of seedlings both in nursery and field from rats, hares and porcupines, goats and cattle is essential; wild pigs eat the tender rhizomes. Constant cutting of the young plants results in useless bushy growth. Many fungi and insects have been found attacking various bamboos.

Bamboos are managed according to a culm-selection method. Clumps have to be intensively worked on for proper distribution of new culms. The new culms, produced along the periphery of the clump, attain their maximum size in one season, but are ready for utilization only after 2–3 years when they are strong. Although bamboos behave like an annual crop, it is not possible to harvest all the culms annually. A cycle of 3–4 years for felling is generally prescribed, a shorter cycle deteriorates the clumps and a longer cycle results in over-crowding. In Andhra Pradesh, Tamil Nadu and Tripura, bamboos are worked on a three-year cycle, whereas in Assam, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh and West Bengal are worked on a four-year cycle.

The yield depends upon the density of the plantation and biotic interference. Uniform culm-size, with 30–50 culms per clump, is maintained for maximum yield which varies between 0.2 and 4.0t/ha. In artificially propagated and properly managed forests, an yield of 6.0 – 7.5t/ha can be obtained.

UTILIZATION

Reclamation —Can be grown to stabilize the shifting sands, streambanks, drainage channels, watersheds, eroded riverbeds, on denuded wastelands, hillslopes, etc.; landslides can be controlled by planting bamboos above and below hillside roads or steep embankments of roads. Serves as a valuable windbreak as it forms impenetrable thickets. Extensive, shallow and fibrous rootsystem, and leaf-litter not only prevent soil-erosion but improve fertility and texture of soil and conserve moisture. Recommended for agrisilviculture, for the bamboos are a promising combination.

Timber—Easy availability, cheapness, strength, straightness, smoothness and lightness combined with hardness, and facility and regularity with which they can be split make bamboos the choice-timber, particularly for houses, huts, etc. in the humid tropics. Used in foundations, and for frames, floors, partition-walls, doors, windows, ceiling and roof, ladders, buckets, vessels, gutters, water-conduits, etc.; can be substituted for steel in concrete after a protective coating. Employed for various types of boards, mats and veneers. Numerous articles of everyday use, such as textiles, mats, screens, blinds, ropes, lashings and wickerwork are made from thin, tough and pliable strips of immature culms. Bamboos form the basic raw material for paperpulp and rayon.

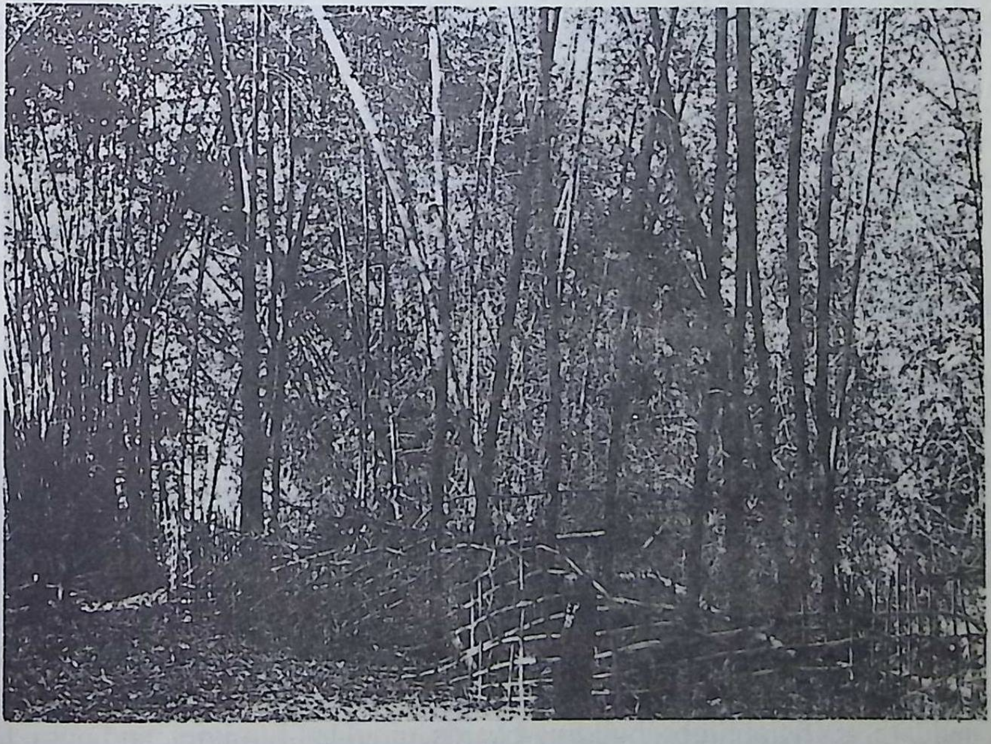
Fuel—Yield good firewood; charcoal from bamboo is reported to have more calorific value than that from other woods; hence, used by goldsmiths. Recently, a liquid-fuel is reported to have been prepared from the culms.

Fodder —Leaves of *Arundinaria racemosa* Munro, *B. arundinacea*, *Cephalostachyum capitatum* Munro, *C. pergracile* Munro, *Chimonobambusa densifolia* (Munro) Nakai, *D. sikkimensis* Gamble, *D. strictus* (crude protein, 15.09%) and *Ochlandra travancorica* are much valued as fodder during scarcity; cattle and horses relish them; elephants, hares and porcupines devour twigs and young leaves. *A. racemosa* is much used in the eastern Himalayas as fodder for ponies. Gaint pandas of western China almost exclusively feed on the soft stems and fresh foliage of *Bambusa* spp and *Dendrocalamus* spp. Mountain gorillas of the eastern Congo and Zaïre depend largely upon tender stems, particularly of *Arundinaria* spp. In North-East India, the fruits of *Melocanna baccifera* (Roxb.) Kurz are readily devoured by cattle, elephants, bisons, rhinoceros, deer, pigs, etc. *B. tulda, B. vulgaris* and *D. strictus* are used as haystack-stabilizers.

Others—Stem / Culm: Young shoots are eaten. In Japan, bamboos are grown as a farm-crop. In China and Indonesia, *Bambusa* spp and *Dendrocalamus* spp are utilized as food. In India, the shoots of *B. arundinacea, B. glaucescens* (Willd.) Sieb. ex Munro, *B. tulda, B. vulgaris, D. giganteus, D. hamiltonii, D. longispathus* (Kurz) Kurz and *Sinobambusa elegans* (Kurz) Nakai are used as vegetable and also pickled. *Seed: B. arundinacea, Cephalostachyum pergracile* and *D. strictus* are extensively eaten during famines. When mixed with honey, they are a delicacy. Also pickled and candied; used for making beer.

BAMBUSA Schreb. (*Poaceae*)

Large, erect, sometimes climbing, grasses, called BAMBOOS; tropical and subtropical and moist parts of Asia, Africa and America; 33 spp in India.



Bambusa arundinacea

Generally grow from sealevel up to 1250 m; many species are planted for preventing erosion, for windbreaks and shelterbelts; used for furniture, wicker-work, agricultural articles, house-building, paper-making, etc.; tender shoots eaten. Propagation is through rhizomes, and through seeds when available.

B. arundinacea (Retz.) Roxb.; Gamble (Fl Br Ind) in part syn. *B. bambos* Druce — THE SPINY OR THORNY BAMBOO

Beng–*Bans;* Guj–*Wans;* Hindi–*Kantabans;* Kan–*Andebidiru;* Mal–*Illi;* Mar–*Bambu;* Oriya–*Bendo;* Sans–*Bahupallava vansa;* Tam–*Mullumungil;* Tel–*Mullabongu, mullaveduru.*

Assam–*Banha;* Bombay–*Kalak;* Himachal Pradesh–*Kallabans;* Jammu–*Lambert;* Kashmir–*Billawar;* Punjab–*Magar bans;* Uttar Pradesh–*Kanwas.*

Habit—Graceful, spinous bamboo. *Rhizome*—short, stout, knotty. *Culm*—dense, 24–30 m/50–60 cm, green or purplish-green when young, turning golden-yellow with prominent nodes and long, hollow internodes, lower ones rooting, often sub-angular, flexuous; grows *c* 33 cm in 24 hrs. *Leaf*—linear or linear-lanceolate, 7–15 cm× 2–20 cm. *Flower*—small, in large panicles, sometimes occupying the whole culm; once in 30–45 years. *Fruit*— oblong caryopsis, with a groove on one side, 5–8 mm long. *Seed*—75,000–105,000/kg; germination 14 days, 30–70%; viable for 6–12 months; needs soaking in water.

Distribution and Ecology—Throughout India in moist parts up to 1250 m, particularly riverbanks, moist, deciduous forests; also in the plains of North-West India and on the hills of Andhra Pradesh, Tamil Nadu and Karnataka. Not particular about soil; can tolerate even clayey and inundated soils. Best growth is on alluvial soils along streams, watercourses forming impenetrable thickets.

Cultivation/Regeneration—Vegetatively propagated; can be grown from seed, if available, in July.

UTILIZATION

Reclamation—Forms impenetrable thickets, extending over vast areas. Planted for reclaiming soils and to prevent erosion by wind and water. Suitable for agro- and social forestry.

A good host for *Santalum album*.

Timber—Culms possess great strength, and are durable; houses, huts, flooring, furniture, boxes, ornamental vases, mats, hats, walking-sticks, ladders, artificial limbs, building-boards, moulded furniture, and pulp for paper and viscose-rayon.

Fodder—Young twigs eaten by elephants and buffaloes; leaf palatable (crude protein, 18.64%) to livestock.

Others—Shoot: Young sprouts cooked as vegetable; tender ones pickled or steeped in oil for direct consumption or made into curries; promotes appetite and helps digestion. Young twigs possess insecticidal properties and lethal to mosquito-larvae. Hollow internodes accumulate a substance, called *tabashir* or *banslochana*, used in medicine. *Leaf:* Astringent, febrifuge, anthelmintic and emmenagogue; used as blood-purifier, and in leucoderma; infusion used as eyewash; mixed with common salt and black pepper used to check diarrhoea in cattle. Extract shows antibacterial activity. *Root:* Poisonous due to cyanogenic glucoside; burnt and applied to ringworm, bleeding-gums and to painful joints. *Seed:* Used as food (protein, 13.1%) when available and reported to be better than rice and wheat.

B. vulgaris Schrad. ex Wendl., non Nees. The Golden Bamboo, The Pantropical Tiger-bamboo, The Yellow- and Green-striped Bamboo

Beng–*Basini bans;* Mar–*Kalaka;* Oriya–*Sundrogai;* Tam & Mal–*Ponmungil.*

Habit — A moderate-sized bamboo, 6–18 m/30–65 cm. *Culm*—bright green or striped green-yellow or yellow, polished. *Leaf*—linear-lanceolate, 15–25 cm long, rough. *Spikelet*— in bracteate clusters, compressed, 6–10-flowered.

Distribution and Ecology—Warmer parts to 1500 m, and cultivated throughout India. Thrives best on riverbanks and grows fast.

UTILIZATION

Reclamation—Binds riverbanks and prevents erosion; can be planted on grassy blanks.

Timber —Used as *B. arundinacea.*

Fodder—Leaf given as forage (crude protien, 10.1%); meal given to chicks to supplement vitamin-A.

Others—Shoot: Though bitter, young shoots (edible protein, 18%) eaten cooked or pickled. *Shoot &Root:* Diuretic, diaphoretic and emollient; fresh root, mixed with tobacco and betel-leaves and macerated in oil, applied to hard tumours. *Leaf:* Considered cooling; wounds and burns poulticed; decoction given in fever, cough and sore throat. Chloroform extract active against *Mycobacterium tuberculosis*. *Seed:* Comparable to rice and wheat (crude protein, 8.9%), but digestibility low.

B. balcooa Roxb. (The Female Bamboo; Beng–*Balku, bhalkibans;* Assam–*Baluka;* Garo–*Beru;* Tripura–*Sil barua*), 20 m/45 cm, found in eastern India, Bihar and eastern Uttar Pradesh; *B. brandisii* Munro can be grown on grassy blanks. *B. burmanica* Gamble, 15–20 m/30 cm, raised in Dehra Dun; *B. glaucescens* (Willd.) Sieb. ex Munro syn. *B. nana* Roxb. ex Munro (CHINESE BAMBOO, DWARF BAMBOO, HEDGE-BAMBOO; Kan–*Hebbidhuru;* Mal & Tam–*Moongh;* Tel–*Bongu, veduru*), 2 m, cultivated as ornament, windbreak and hedge; *B. guadua* Humb. & Bonpl. syn.*Guadua angustifolia* Kunth; *Nastus guadua* (Humb. & Bonpl.) Spreng., a native to tropical America, *B. nutans* Wall.ex Munro (Beng–*Makla nal bans*; Hindi–*Mala bans;* Assam–*Bidhuli, deobans;* Khasi–*Sering jai*; Kuki–*Wal-malang;* Lepcha–*Mahlu;* Mikir–*Chak;* Tripura–*Pichli*), an ornamental bamboo, found from Himachal Pradesh to Arunachal Pradesh and Meghalaya, up to 1500 m, and cultivated near villages, roadsides and canalbanks. *B. pallida* Munro (Assam–*Walkathai;* Cachar–*Bakhal;* Khasi–*Sken;* Lepcha–*Pashipo;* Mikir–*Chok-duk;* Naga–*Tesero, watoi*), 13–18 m/25–50 cm, found from Sikkim to Arunachal Pradesh, Assam, Meghalaya, up to 1250 m; *B. polymorpha* Munro (Assam–*Belua;* Tripura–*Bethua*),up to 27 m/0.5–1.5 m, found in Assam and West Bengal and introduced into Tamil Nadu on different types of soils, up to 750 m. *B. spinosa* Roxb., non Blume ex Nees syn. *B. arundinacea* Gamble (Fl Br Ind) in part (THE SPINY BAMBOO OF EASTERN INDIA; Beng–*Behor;* Hindi–*Beha bans;* Assam–*Koto*), 25 m/1.2 m, found in eastern India and Tamil Nadu and cultivated in other parts of India; *B. tulda* Roxb. (THE CALCUTTA CANE, COMMON BAMBOO OF BENGAL; Beng–*Tulda;* Hindi–*Deobans;* Mal–*Makar;* Assam–*Mirtenga;* Garo–*Wati;* Kol–*Pepe siman;* Lepcha–*Bleeng;* Mikir–*Artungsa-u;* Mizoram–*Rawthing;* Santal–*Mak;* Tripura–*Matela*), 6–21 m/50 cm, a gregarious bamboo of eastern India and Orissa. All these bamboos are used as *B. arundinacea*.

BARRINGTONIA J. R. & G. Forst. (*Barringtoniaceae*)

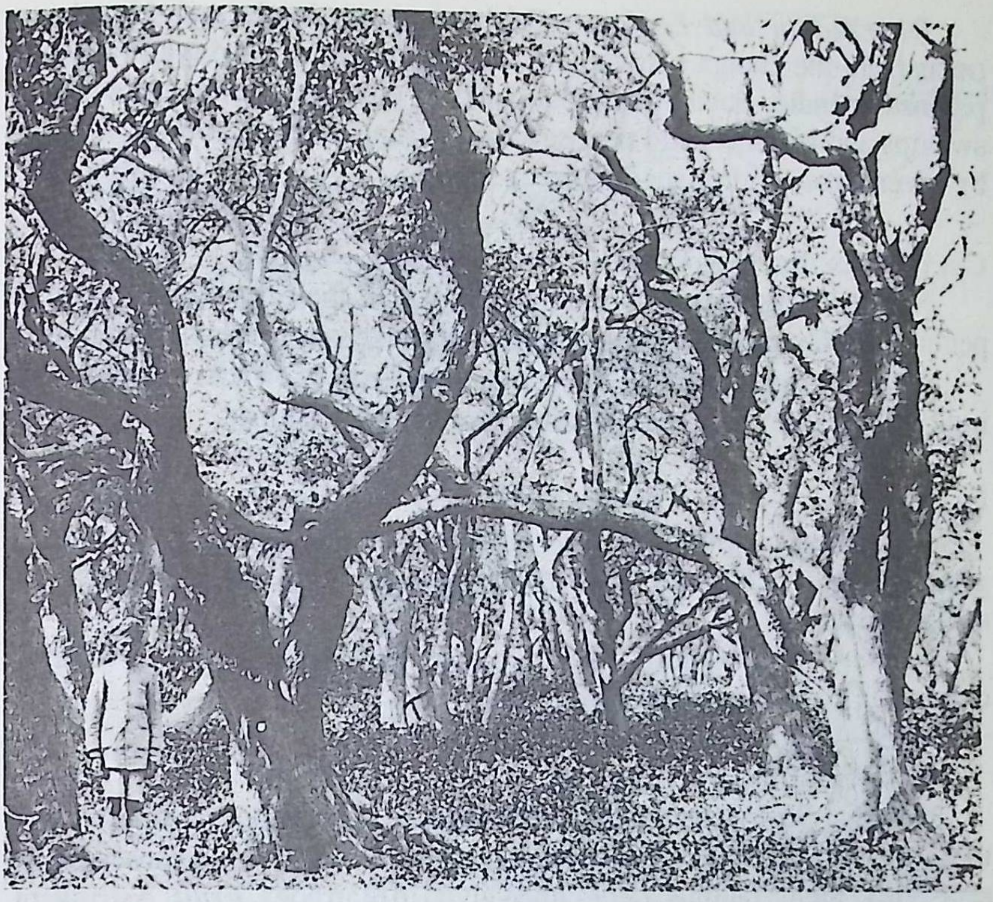
Trees; tropical Africa, Asia, Australia and Polynesia; 4 spp in India.

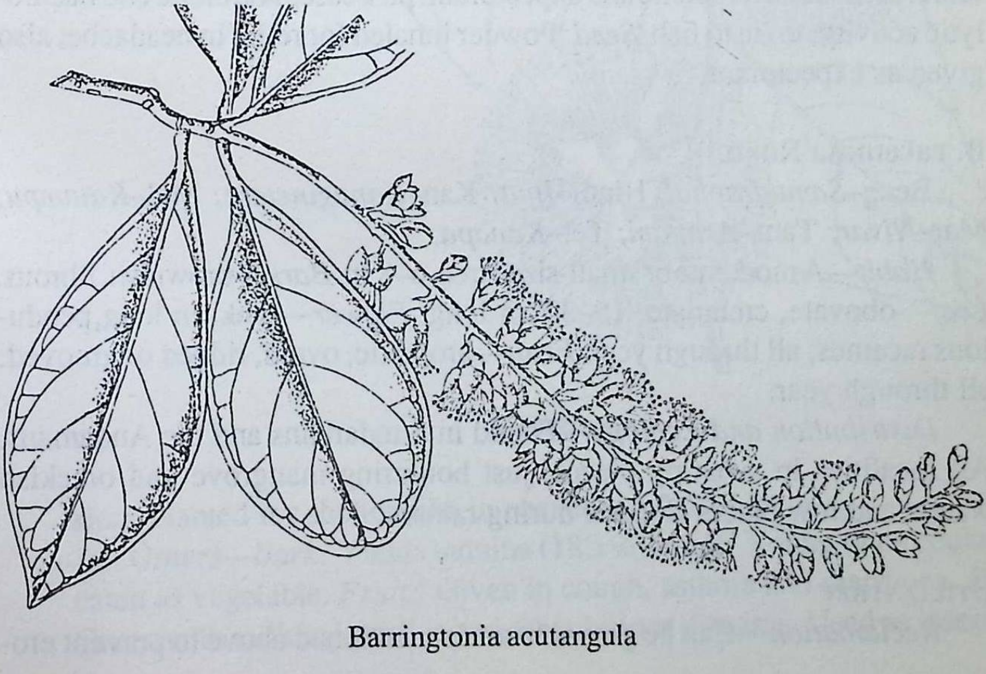
B. acutangula Gaertn. INDIAN OAK

Beng & Hindi–*Hijal;* Guj–*Samudraphal;* Kan–*Holekauva;* Mal–*Attampu;* Mar–*Dattephal;* Oriya–*Hinjolo;* Tam–*Adampa;* Tel–*Kanapachettu.*

Assam–*Kanapa.*

Habit—An evergreen tree, 9–12 m/1.8 m. *Bark*—dark brown, rough, fissured. *Leaf*—obovate, minutely denticulate, crenate, narrowed into petiole, clustered at the end of branch. *Flower*—long, fragrant, white, with bright-red stamens; mainly during March–May. *Fruit*—bluntly quadrangular, oblong, 2.5–4.0 cm×1.75 cm; ripens during July–September; 1400/kg. *Seed*—solitary, exalbuminous; germination 15–20 days, 90–100%; viable for a short period.





Barringtonia acutangula

Distribution and Ecology—Fairly common in the sub-Himalayan tracts from the Ganga eastwards to Assam, and from Madhya Pradesh to peninsular India. Found along the banks of streams, around the edges of swamps and marshes, and near seacoast. Usually frost-hardy but affected by severe frost or drought even near streams.

CULTIVATION/REGENERATION

Natural Regeneration—Freely occurs near the trees. Germination is peculiar; seedlings appear with a bulged tuber-like structure containing food.

Artificial Regeneration—Recommended to be grown from direct sowings; transplanting also can be done during July–October.

UTILIZATION

Reclamation—Found suitable for afforestation of swampy or marshy grounds; can be grown near the seacoasts. Also recommended for social forestry.

Timber—Boat-building, paddy-pounders, cabinet-work, carts, agricultural implements; and tool-handles.

Fuel—Very good firewood (5075 kcal/ kg).

Fodder—Tender leaf given.

Others—*Bark:* Astringent, febrifuge; used in diarrhoea; decoction used to relieve toothache and gum-troubles; poultice relieves pain caused by insect-bites. Yields tannins. *Leaf:* Juice given in diarrhoea. *Fruit:* Astringent, tonic, anthelmintic, emetic and expectorant; possesses antibiotic and haemolytic activity; toxic to fish. *Seed:* Powder inhaled for relief in headache; also given as expectorant.

B. racemosa Roxb.

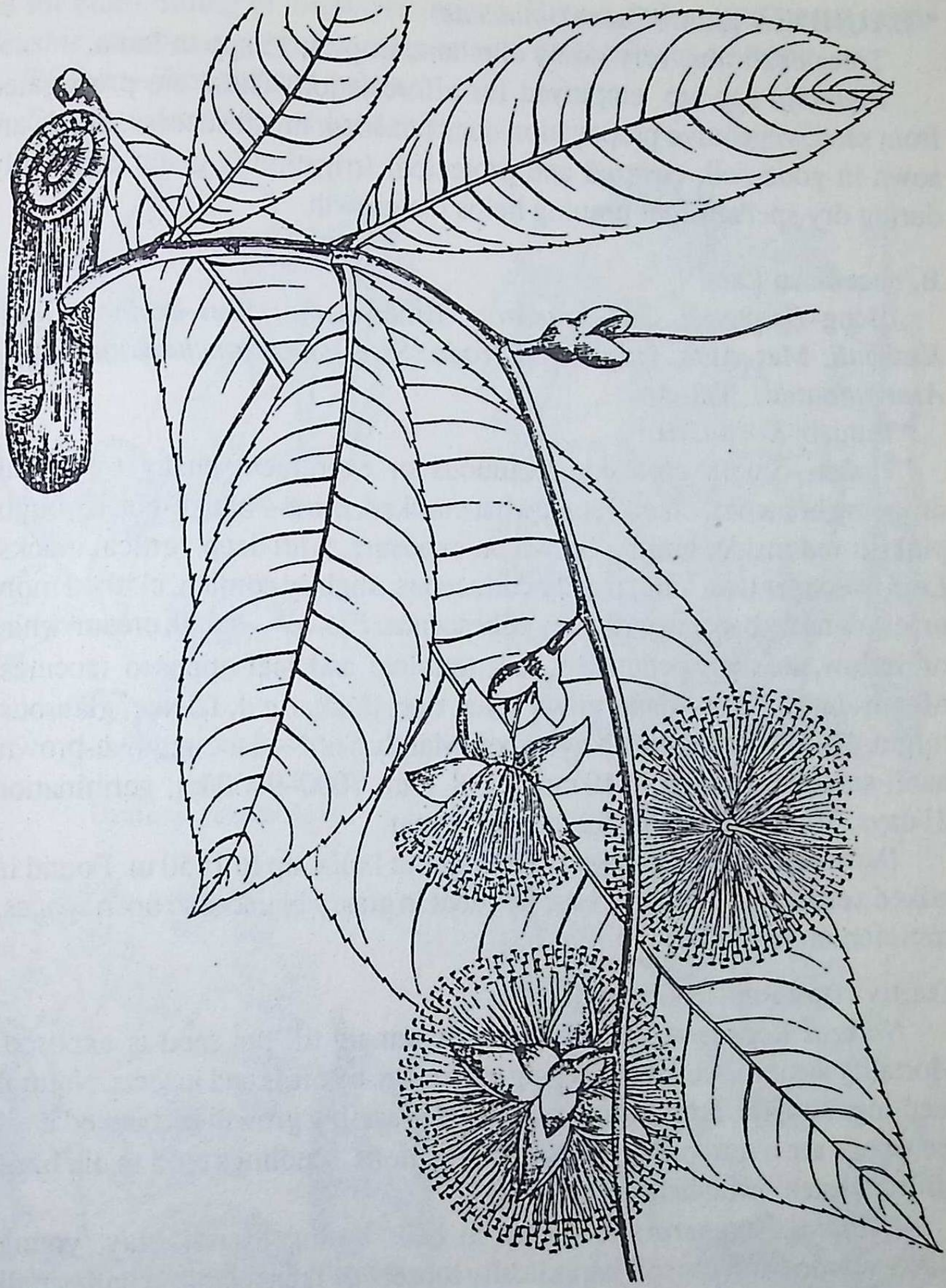
Beng–*Samudraphal;* Hindi–*Ijjut;* Kan–*Kanaginetere;* Mal–*Katampu;* Mar–*Nivar;* Tam–*Arattam;* Tel–*Kanapa.*

Habit—A moderate or small-sized tree, 6–8 m. *Bark*—brownish, fibrous. *Leaf*—obovate, crenulate, 15–30 cm long. *Flower*—pink, in long, pendulous racemes; all through year. *Fruit*—aromatic, ovoid, ridged or grooved; all through year.

Distribution and Ecology—Found in Sundarbans and the Andamans. All localities in swampy places, just bordering mangrove and brackish waters and low places flooded during rains.

UTILIZATION

Reclamation—Can be grown in areas mentioned above to prevent ero-



B. racemosa

sion. Planted for shelterbelts in coastal sand-drift areas.

Others—Bark: Yields tannins (18.1%). *Leaf:* Young ones cooked and eaten as vegetable. *Fruit:* Given in cough, asthma and diarrhoea. *Kernel:* Given with milk in jaundice and other bilious diseases. Used as insecticide.

* **BAUHINIA** Linn. *(Caesalpiniaceae)*

Trees or shrubs, very rarely climbers; tropics; 15 spp in India.

Bauhinia spp are employed for afforestation. These are propagated from seed; vegetative propagation does not show much success. Seeds are sown in good soil, covered and protected. Irrigation is given especially during dry spells. Light pruning helps the growth.

B. racemosa Lam.

Beng–*Banraj;* Guj–*Asundro;* Hindi–*Astha;* Kan–*Banne;* Mal–*Kotapuli;* Mar–*Apta;* Oriya–*Omboroda;* Sans–*Swetakanchanamu;* Tam–*Araivattaatthi;* Tel–*Ari.*

Punjab–*Kosundra.*

Habit—Small, crooked, deciduous or evergreen, bushy tree, with drooping branches. *Stem*—somewhat crooked. *Bark*—bluish-black, rough, pinkish-red inside, turning brown on exposure, with deep vertical cracks. *Leaf*—broader than long, rigidly coriaceous, slightly cordate, clothed more or less densely beneath with grey pubescence. *Flower*—small, cream-white or yellow, in short-peduncled, lax, terminal and leaf-opposed racemes; March–June. *Fruit*—dark brown when ripe, thick, rigid, falcate, glabrous, turgid, 12–20-seeded pod; November–March. *Seed*—dark, reddish-brown, hard, smooth, shining, 9–10 mm × 3–8 mm; 7000–9000/kg; germination 21 days, 70–100%; viable for at least 1 year.

Distribution and Ecology—Throughout India, up to 1650 m. Found in mixed xeromphic thorny forests; frequent in grassy blanks and open spaces; common on dry hills.

CULTIVATION/REGENERATION

Natural Regeneration—Fallen pods remain till the seed is exposed. Mortality is more because of drying or damage by birds and insects. Natural seedlings struggle through low weeds and grass, but growth is checked until the weeds are overtopped. In dry, hot situations, seedlings tend to die back till rootsystem establishes.

Artificial Regeneration—Sown in lines during March–May; young plants weeded and the soil periodically loosened. Transplanting with small, nursery-raised plants during the first rains is recommended; regular watering required. Stumps can be planted.

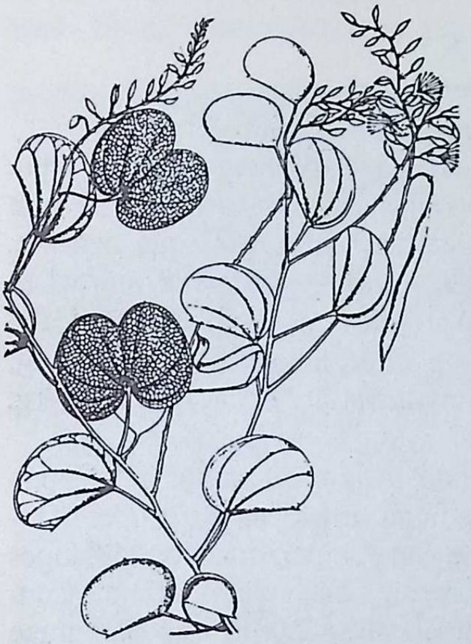
UTILIZATION

Reclamation—Useful species for checking soil-erosion in arid areas and for blank-filling in forest-plantations. Grown under agroforestry with *Eleusine coracana*, gingelly, redgram and cotton. Fixes nitrogen.

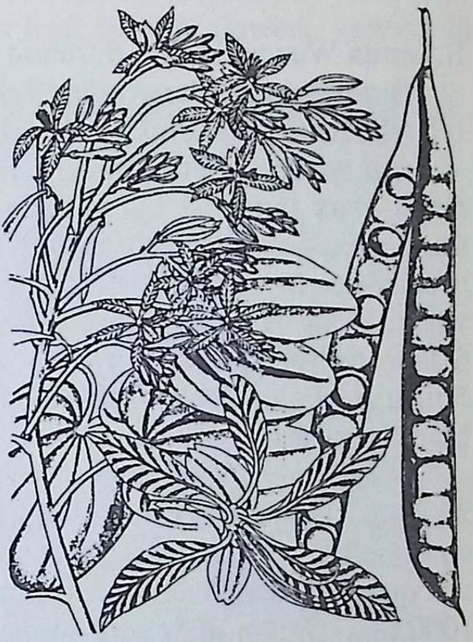
**Bauhinia* Linn. *sensu stricto*.

Timber—Ploughs and yokes.

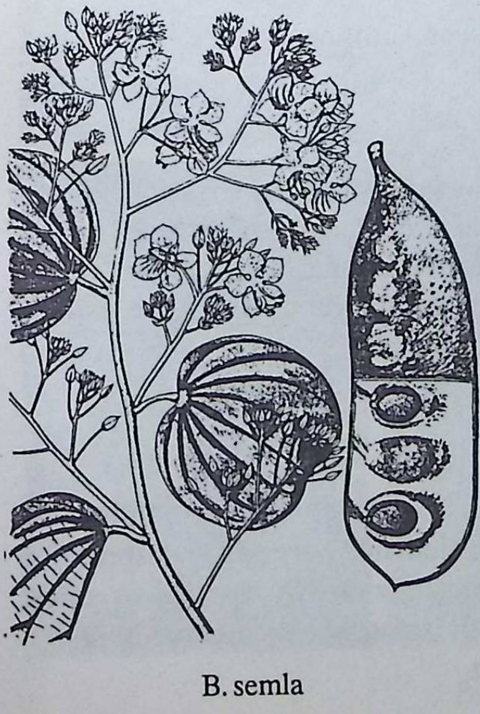
Fodder—Leaf lopped for cattle.



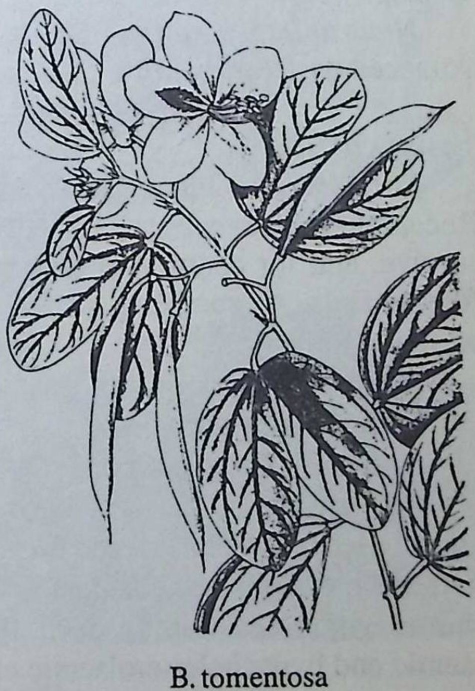
Bauhinia racemosa



B. purpurea



B. semla



B. tomentosa

Others—Plant: Blood-purifier. *Bark:* Yields a gum and strong fibre for cordage. Astringent, anti-inflammatory, cholagogue; used for dysentery. *Leaf:* Used for *bidis;* with onion given for diarrhoea; decoction given in malaria. *Seed:* Antibacterial.

B. semla Wunderlin syn. *B. retusa* Roxb.

Hindi–*Semla;* Mar–*Koilar;* Tel–*Nirpa.*

Himachal Pradesh–*Karalla;* Mundari–*Laba;* Punjab–*Kural.*

Habit—A medium-sized, deciduous tree, handsome when in fruit. *Bark*—dark brown, longitudinally cracked, pale pink inside, 8–13 mm thick. *Leaf*—rigidly coriaceous, broader than long, glabrous beneath, usually deeply cordate, 10–15 cm broad. *Flower*—yellow or yellowish-white, in big terminal panicles; September–November. *Fruit*—hard, flat 6–8-seeded pod, 10–17 cm × 3.0–3.8 cm, rich crimson before ripening; January onwards. *Seed*—dark brown, smooth, flat, 1.25 cm diam; 1500 /kg; March onwards; germination 70–100%.

Distribution and Ecology—Throughout the greater part of India, up to 2500 m. Always found on well-drained ground, hillslopes or the sides of ravines; mainly occurs on shale, sandstone and conglomerate, on hillslopes and quarzite rock, limestone, degraded ravine-lands, with a rainfall from 1000 to 2250 mm; new soils formed by landslips and erosion encourage natural regeneration.

CULTIVATION/REGENERATION

Natural Regeneration—Scattered seed germinates early in the rains. Attacked by *Dendrophthoe falcata.*

UTILIZATION

Reclamation—Planted in blocks; covers hillsides and *terai* and *babhar.* Recommended for soils mentioned above where many other species cannot survive, and for controlling erosion in ravines and landslips and newly formed soils. A promising species for reforestation of limestone soils in western Himalayas.

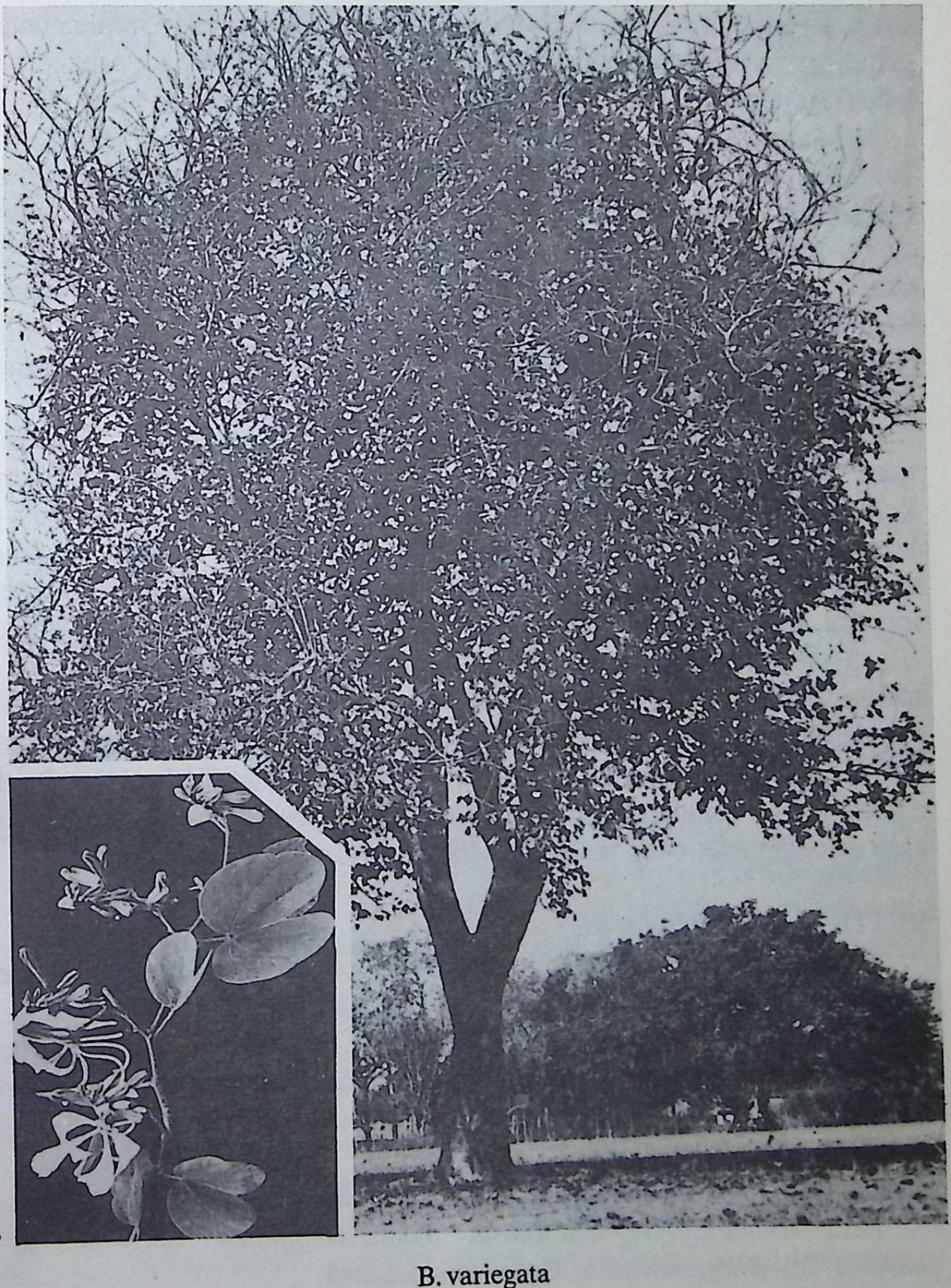
Timber—Rafters, scantlings and posts.

Fuel—Yields firewood.

Fodder—Leaf good fodder.

Others—Bark: Yields a clear gum, *semul gond*, resembling gum arabic; used in sweetmeats and for sizing cloth and paper, in waterproofing terraced roofs, and in charcoal briquettes. Externally applied to sores; emmenagogue and diuretic. *Seed:* Protein isolate shows marked hypoglycaemic and hypocholesterolaemic effect.

B. purpurea Linn. (BUTTERFLY-TREE, GERANIUM-TREE, ORCHID-TREE; Beng–*Devkanchan;* Hindi–*Khairwal;* Kan–*Baswanapada;* Mal–*Chuvanna-mandaram;* Mar–*Atmatti;* Tam–*Mandari;* Tel–*Kaanchanamu*) is a medium-sized, evergreen tree, 3.0–4.5 m/0.9–1.2 m, with dark-brown bark, rigidly sub-coriaceous, glabrous leaf, fragrant flowers, varying in



B. variegata

colour from white to deep rose to lilac or purple in short-peduncled, few-flowered, terminal or axillary corymbs (September–December) and glabrous, flat, 10–15-seeded pods (January–May), brown, compressed seeds. (4000–5000/kg; germination 4–21 days, 70–100%); found throughout India on hillslopes, in valleys, and along streams and ravines. Recommended for social forestry and block-plantings on hills and *terai* and *babhar* zones. Reported to fix nitrogen. Timber useful for agricultural implements, scantlings, rafters, interior construction and for matches. Leaf lopped for fodder (protein, 13.15%). Flowerbuds eaten as vegetables and pickled.

B. tomentosa Linn. (YELLOW BAUHINIA, BELL-BAUHINIA, ST THOMAS TREE; Guj–*Piloasundro;* Hindi–*Kachnar;* Mal & Tam–*Kokkumandara;* Mar–*Aptu;* Sans–*Peetakanchana;* Tel–*Adavimandaaramu*) is an erect shrub, with coriaceous leaves, yellow-coloured, aromatic flowers, with maroon dot at the inner base of petals, 6–10-seeded, glabrous fruits, found from Delhi to West Bengal, extending into peninsular India; specially prized for avenues, roadsides and gardens. Fixes nitrogen. Timber used as fuel, and for carpentry.

B. variegata Linn. (BUDHIST BAUHINIA, MOUNTAIN-EBONY, ORCHID-TREE; Beng & Mar–*Raktakanchan;* Guj–*Kovindara;* Hindi–*Kachnar;* Kan–*Arisinatige;* Mal–*Chuvannamandaram;* Sans–*Kovidara;* Tam–*Shemmandarai;* Tel–*Devakaanchanamu*) is a medium-sized, deciduous tree, with grey bark, rigidly sub-coriaceous, deeply cordate leaf, large, fragrant, variously coloured flowers (February–April), hard, flat, glabrous, 10–15-seeded fruits (May–June), and brown seeds (2800–3520 /kg; germination 30 days, 70–100%), found throughout India, up to 1300 m. Recommended for growing on boundaries, on hills in *terai* and *babhar* zones and for agricultural implements; a moderately good fuel (4791 kcal/kg). Leaf a good fodder (crude protein, 15.6%) and a source of vitamin-C. Flower used as vegetable; buds pickled; extract antibacterial.

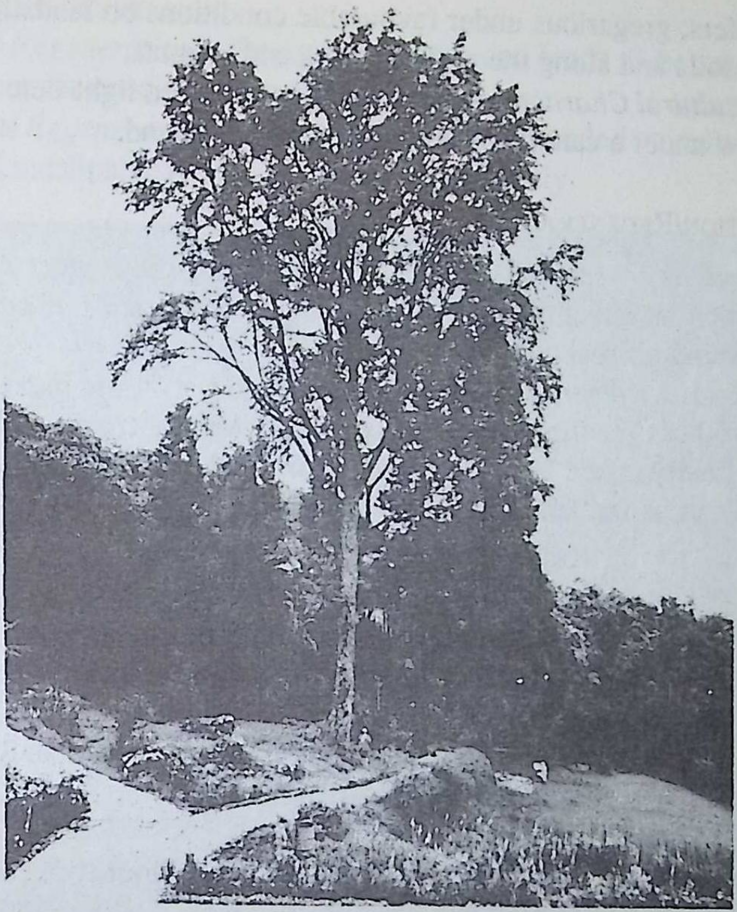
BETULA Linn.(*Betulaceae*)

Ornamental trees or shrubs, commonly known as BIRCHES; temperate regions of northern Hemisphere; 3 spp in India.

Typical pioneers with light seeds; tolerate low status of nutrients and grow rapidly on moist as well as dry sites and mine-wastes. Widely used in rehabilitation.

B. alnoides Buch.-Ham. ex D.Don INDIAN BIRCH, NAGA-BIRCH

Beng–*Hlosunli;* Guj–*Bhojpatra;* Hindi–*Bhujpatra;* Sans–*Bhurjapatram;* Tel–*Bhojapatramu;* Urdu–*Bhurjapatra.*



Betula alnoides

Assam–*Dieng-ling;* Garhwal–*Sauer;* Kumaun–*Banutis;* Nagaland–*Teri-ching;* Punjab–*Shagru.*

Habit—A moderate to large-sized, deciduous tree, up to 30 m/ 1.2–1.5 m, with straight, clear bole, up to 15 m. *Bark*—grey to greenish-brown, shining with horizontal, oblong lenticels, peeling off in horizontal rolls. *Leaf*—ovate, ovate-lanceolate or oblong 7.0–15.0 cm, base cuneate, rounded or cordate. *Flower*—male and female, in catkins, 5–12 cm, slender, fascicled, pendulous. *Fruit*—a nut, with wing broader than itself, dispersed to a long distance. Seed— 9,365,800–13,875,000/kg; May–June; germination 35–56 days, 10–70%; viable up to 12 months; can be stored at room temperature; needs stratification.

Distribution and Ecology—Temperate and subtropical Himalayas, on the Khasi and Naga hills, and the mountains of Manipur, between 900 and 3000 m. Found in high forests mixed with oak and other broad-leaved trees and conifers; gregarious under favourable conditions on landslips, newly exposed soils and along the moist ravines and torrents.

Silvicultural Characters—Not a very pronounced light-demander, but does grow under a canopy or on weed-covered ground.

CULTIVATION/REGENERATION

Natural Regeneration—Tends to become gregarious when conditions favour, such as landslips and other newly exposed soils; seedlings frequently found on roadcuttings.

Artificial Regeneration—Fresh seed broadcast in the nursery during summer; 60 cm seedlings, preferably without leaves, transplanted in cold weather. Easily raised from cuttings in moist soil under shade during monsoon and can be transplanted in the rainy season.

UTILIZATION

Reclamation—Recommended for afforestation and control of erosion of landslips, newly exposed soils, moist ravines and torrents; planted for shade in tea plantations.

Timber—Cabinet-work, turnery, spools, pillboxes, tool-handles, planks, saws, veneers, very good for plywood; and pulp.

Fuel—Provides firewood.

Others—*Bark:* Dry bark eaten like biscuits; its flour cooked into food.

B. cylindrostachys Gamble LOW-LEVEL DARJILING BIRCH

Beng–*Saur*.

Garo–*Bol-gakkel;* Khasi–*Dieng-ling;* Lepcha–*Sunli*.

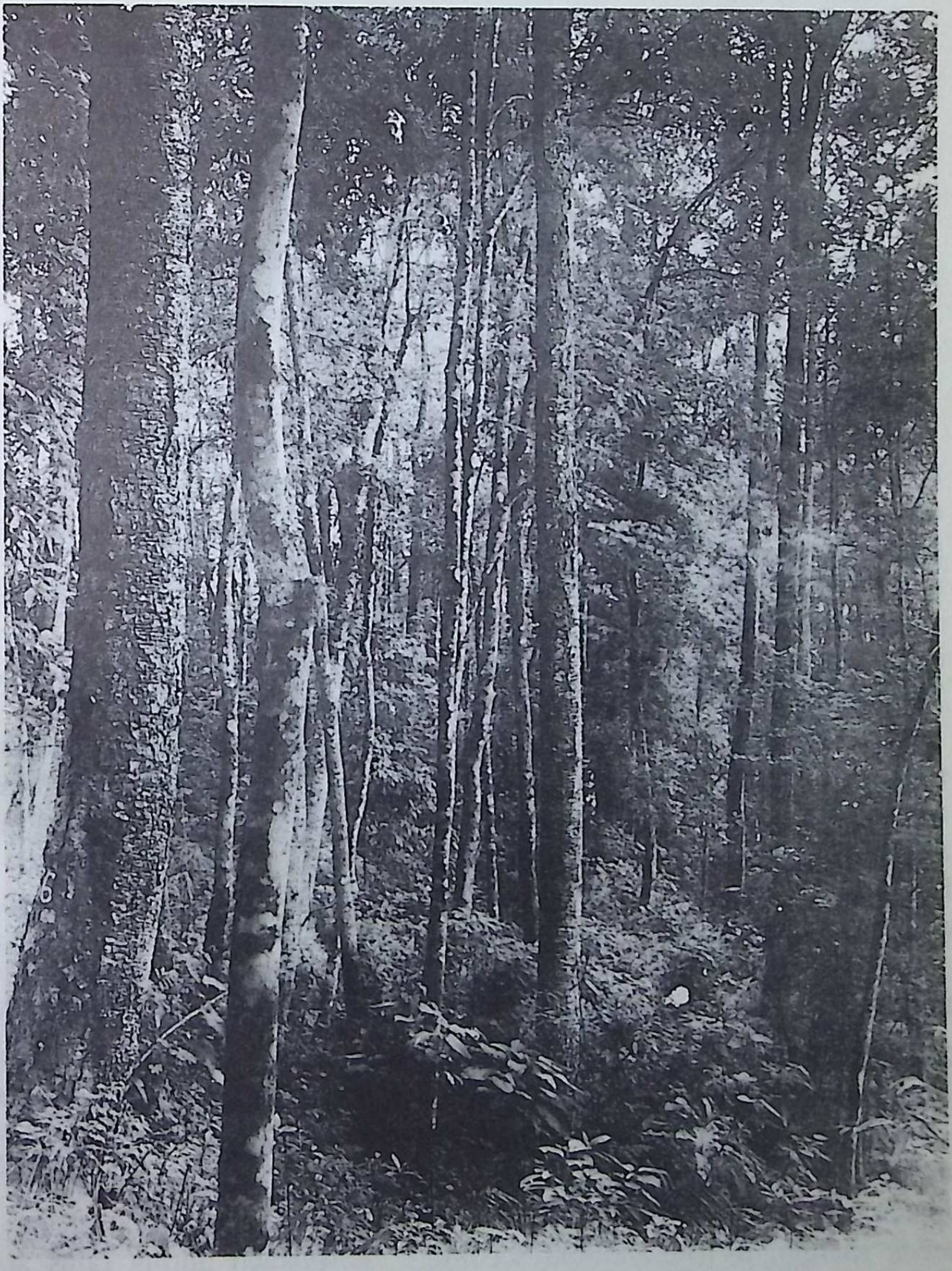
Habit—A lofty tree, with spreading crown, up to 36 m/1.8–2.4 m. *Stem*—straight, cylindric. *Bark*—pink to grey, exfoliating in large, vertical, papery flakes which often overhang. *Leaf*—ovate-lanceolate, coriaceous, glabrous above, dotted beneath. *Flower*—in coloured, pendulous, staminate catkins, which appear before the leaves, and the much smaller pistillate catkins. *Fruit*—scale-like, with 2, membranous-winged margins on 7.5–10.0 cm long panicles; January–March. *Seed*—13,679,000–14,000,000/kg; March; germination 60 days, 0–30%; viable for short period; needs stratification.

Distribution and Ecology—Darjiling hills of West Bengal and Assam, up to 1800 m. A hardy species, growing along streams of *terai* forests in sandy and loamy soils. Tends to become gregarious on landslips and other exposed soils; at times forms dense crops.

CULTIVATION/REGENERATION.

Natural Regeneration—Freely germinates and tends to become gregarious whenever conditions are favourable.

Artificial Regeneration—Direct sowing recommended on soils newly exposed or landslips; may also be transplanted in July.



B. cylindrostachys

UTILIZATION

Reclamation—Suitable for afforesting landslips and newly exposed soils at lower elevations. Planted for anti-erosion in the Kalimpong area. Recommended for agroforestry.

Timber—Plywood.

Fuel—Provides firewood and charcoal.

Others—Bark & Leaf: Yield an essential oil (0.12%).

BISCHOFIA Blume (*Bischofiaceae*)

Trees; tropical Asia; 1 sp in India.

B. javanica Blume BISHOPWOOD

Beng–*Kainjal;* Hindi–*Paniala;* Kan–*Gobranerale;* Mal–*Nira;* Mar–*Boke;* Oriya–*Dingiri;* Tam–*Thondi;* Tel–*Nalupumushti.*

Andamans–*Ye badauk;* Assam–*Uriam;* Meghalaya–*Dieng-soh-tug;* TRADE–*Bishopwood, urium.*

Habit—A deciduous or evergreen, fast-growing tree, up to 20 m/ 1.5–2.5 m. *Stem*—clear, cylindrical bole, 9–12 m. *Bark*—dark brown, exfoliating in angular scales. *Leaf*—trifoliolate: leaflets variable, ovate to oblong-lanceolate or elliptic-oblong, acuminate, bronze-green. *Flower*—green, greenish-yellow, in slender, axillary or lateral, paniculate racemes. *Fruit*—reddish-brown to blue-black, compressed-globose, fleshy, 3–4-seeded berry; December–March. *Seed*—dark brown, embedded in soft, colourless, edible pulp; 58,400–104,000/kg; October; germination 14–21 days, 70–100%; viable for 1 year.

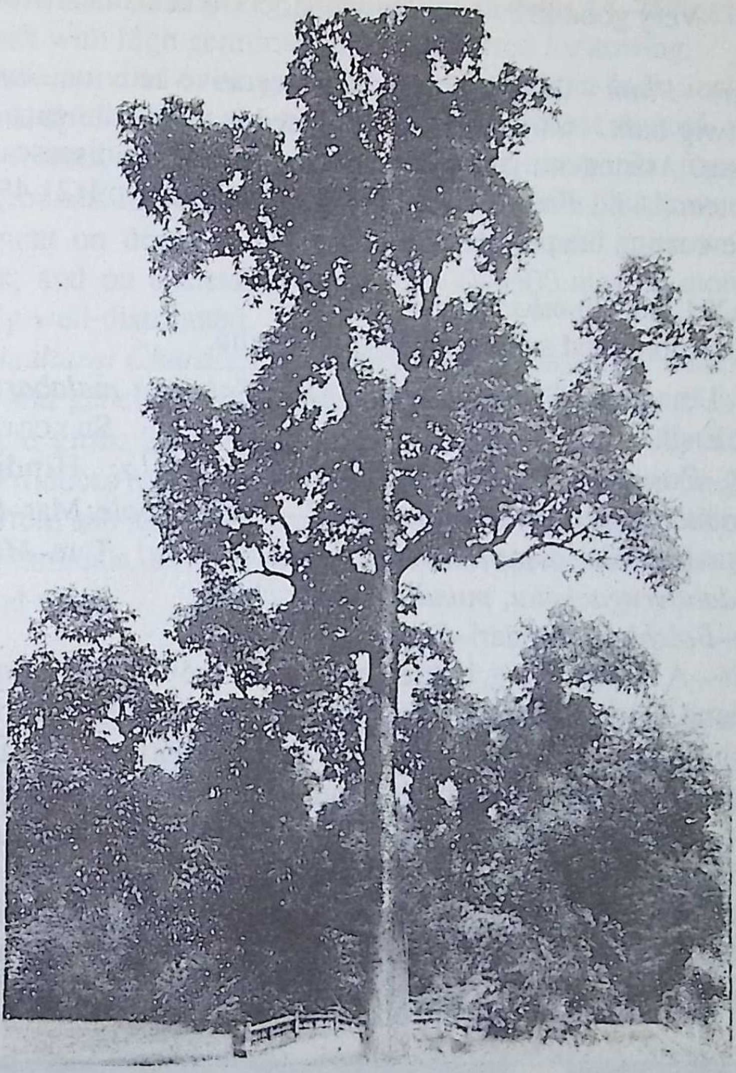
Distribution and Ecology—Sub-Himalayas from Kumaun eastwards throughout the eastern India, in the Deccan Peninsula throughout eastern and western ghats, up to 450 m; also found in the Andamans; grown in avenues and in plantations for shade. Characterstic of moist, shady, river-banks and swamps and ravines, with heavy rainfall; capable of growing in dry places, bearing heavy crop, probably with irrigaton.

Silvicultural Characters—Withstands moderate shade; resists ordinary frost; needs weeding. Good coppicer. Trained in plantations for shade.

CULTIVATION/REGENERATION

Natural Regeneration—Freely germinates in moist soil under shade.

Artificial Regeneration—Direct sowing of fresh seed or transplanting, stump-planting or planting root- and stem-cuttings. Seeds sown during September–October in porous soil-beds and watered. Once germinate, soil needs stirring; 8–10-month-old seedlings transplanted during rains at 7–10 m distance.



Bischofia javanica

UTILIZATION

Reclamation—Suitable for afforestation of areas with high watertable; leaves shed throughout the year providing mulch which conserves moisture, add humus and control erosion. Characterstic of ravines, riverbanks and swamps; grown for shade in plantations of tea, coffee and cardamom; capable of growing on dry soils also; recommended for agro- and social forestry.

Timber—Bridges, houseposts, pile- foundation, sleepers, rafters, boats, dugouts, well, wheels, cheap pencils, penholders, packing-cases, and for paper-pulp.

Fuel—Very good firewood (sapwood, 5316 kcal; heartwood, 5142 kcal/kg).

Others—Plant: Extract shows anti-ulcerative activity. *Bark:* Yields tannins (twig-bark, 16%) and a red dye. Used in throat ailments, fever and burns. *Leaf:* Astringent; given in toothache and in eye-diseases; contains crude protein (18%). *Fruit:* Eaten. *Seed:* Yields a drying oil (21.4%). Useful in surface-coating the products.

BOMBAX Linn. (*Bombacaceae*)

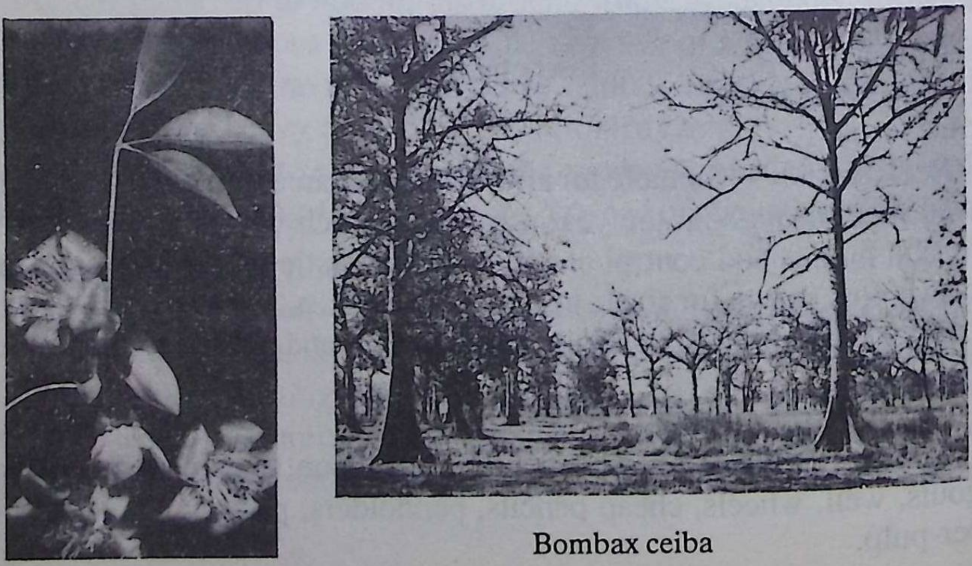
Trees; tropics and subtropics; 2 spp in India.

B. ceiba Linn. syn. *B. malabaricum* DC.; *Salmalia malabarica* (DC.) Schott & Endl. SILKCOTTON TREE

Beng–*Pagun, simul;* Guj–*Sawar, shimalo;* Hindi–*Semul;* Kan–*Kempubooruga, mullubooruga;* Mal–*Mullilabpoole;* Mar–*Kantesavar;* Oriya–*Bouroh;* Sans–*Salmali, kantakadruma;* Tam–*Mullilavan;* Tel–*Kondaboorugachettu, mundlaboorugachettu.*

Garo–*Bolchhu;* Mundari–*Edelsong.*

Habit—A fast-growing, buttressed tree, up to 59 m/6 m or more, up to 35 m around buttress. *Stem*—clear bole 24–30 m, with hard prickles at base, having horizontal branches in more or less whorls. *Bark*—thick, pale ash to silver-grey, smooth becoming rough, with irregular cracks. *Leaf*—large, spreading, digitate, with 5–7, lanceolate, 10–12 cm long leaflets. *Flower*—numerous, large, fleshy bright crimson-yellow or orange. Clustered at the end of branches, rarely unisexual; January–March; starts at 8 years. *Fruit*—oblong-ovoid, woody capsule, 10–19 cm × 5 cm ; 50/kg; March–May. *Seed*—many, black, irregular obovoid, smooth with dense,



Bombax ceiba

silky hairs; 21,430–38,500/kg; germination 25 days, 14–75%; viable for 2 years; fresh with high germination and preferred for sowing.

Distribution and Ecology—Common throughout India including the Andamans, up to 1500 m; grown in avenues. Typical of alluvial- and savannah-type forests, tending to be gregarious near riverbanks; found in open grazing grounds. Prefers deep, sandy loam of granite but shows maximum development on deep, alluvial soils of valleys and deep well-drained hillslopes; and on skeletal soils, with 500–4600 mm or more rainfall, preferably well-distributed.

Silivicultural Characters—A strong light-demander. Fairly drought-resistant and generally frost-hardy. Requires little weeding; thinning increases the girth; 20–40-year rotation in moist areas, depending upon growth. Produces rootsuckers. Coppices well in the early years. Thick bark protects from and resists fire and plant recovers from injury. Needs protection from animals. Several pests have been recorded to cause damage to leaves and wood.

UTILIZATION

Reclamation—Eminently suited for afforestation of new grounds, grasslands, gullies and ravines, riverain tracts; also useful in controlling soil-erosion; highly suitable for agro- and social forestry. Recommended for block-planting.

Timber—Plywood, teaboxes, match-industry, packing-cases; canoes, shingles, toys, pencils, musical instruments, penholders; frames, coffins, brush-handles, wellcurbs, woodwool; and pulp.

Fodder—Lopped for fodder (crude protein, 18.69%); *tasar*-silkworms can be fed. Seed (crude protein, 36.5%) and cake are excellent cattle-feed.

Others—Bark: A famine food (protein, 1.2%; tannins, 0.4%); used in medicine as demulcent and styptic. Exudes an edible gum from natural wounds; stimulant, tonic, demulcent, antidysenteric, analgesic; useful in giardiasis and diarrhoea. Mixed with ashes and castor-oil, used for caulking ironpans for boiling sugar. *Root:* Eaten raw or roasted as sweetpotato (protein, 1.2%). Astringent, used in dysentery, as aphrodisiac and cardiac. *Leaf:* Eaten; yields tannins. *Flowerbud:* Eaten by humans and animals (crude protein, 1.38%); immature calyx used as vegetable, and favourably compares with carrot, cabbage, etc. A conserve is made; dried, powdered flowers made into a bread with or without corn; a source of nectar. *Fruit:* Tender medicinal. *Seed:* Possesses antibacterial property. Yields an oil (22.3%); used as a substitute for that of cotton-seed. *Floss:* known as INDIAN

KAPOK, light, buoyant, soft, strong, elastic, resilient, water-repellant, suitable for stuffing lifebelts, mattresses, instruments, plushes, laces, etc.

BORASSUS Linn. (*Arecaceae*)

Tall, stout palms; tropical Asia, Africa and Australia; 1 sp in India.

B. flabellifer Linn.; Becc. & Hook. f. (Fl Br Ind) in part THE PALMYRA-PALM

Beng–*Tal;* Guj, Hindi & Mar–*Tad;* Kan–*Taalimara;* Mal & Tam–*Karimpana;* Oriya–*Talo;* Sans–*Thrinaraja;* Tel–*Taadi-(taati) chettu.*

Assam–*Tal;* Lushai–*Siallu;* Santal–*Tale.*

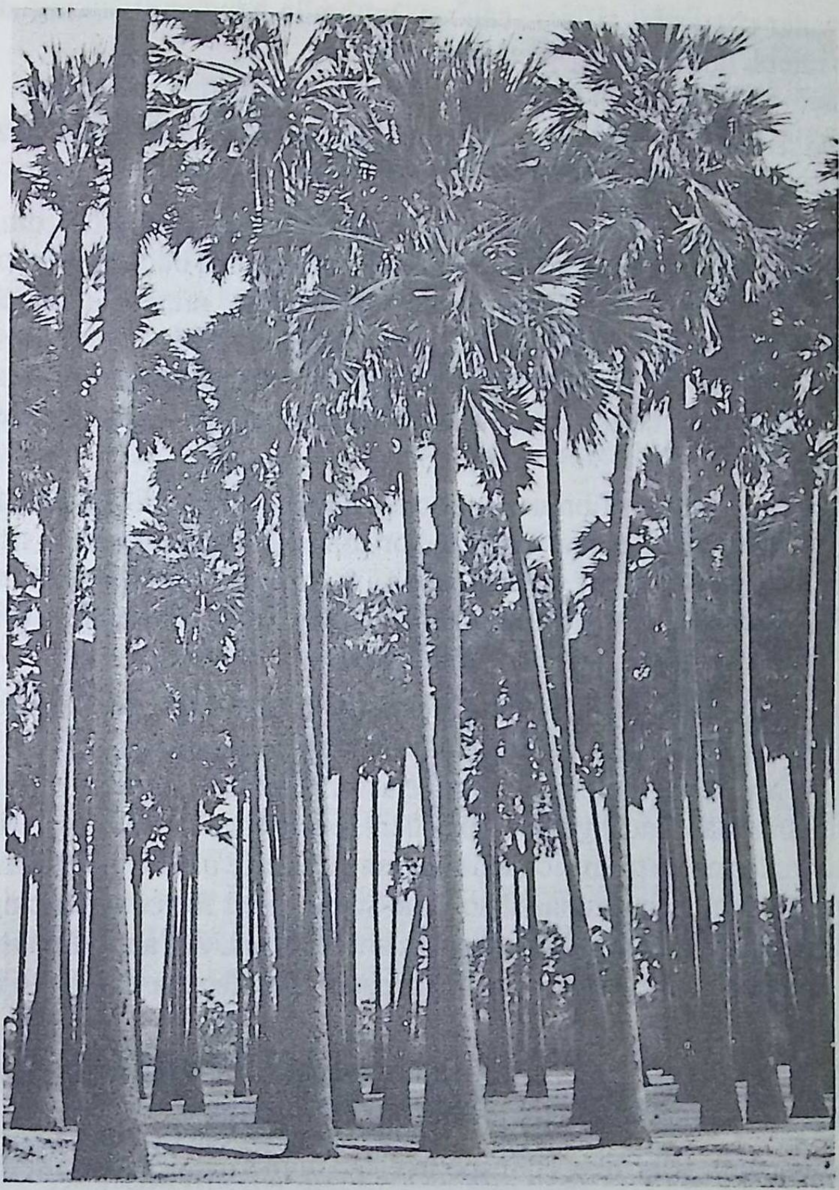
Habit—A tall, erect palm, with a crown, up to 31 m/1.0–3.0 m. *Stem*—tall, blackish-grey, cylindric, generally straight, swollen at the base or above the middle and tapering, marked with black, narrow scars of petioles, with dense mass of rootlets near the ground; young stems covered with leafbases or petiole-bases. *Leaf*—palmately divided, fan-shaped, with 0.6–1.2 m long spinescent margined petiole; lamina 0.9–1.5 m in diam, rigidly coriaceous, divided into bifid-lobes, 60–80 segments. *Inflorescence*—spadices very large, stout: male with stout, cylindric branches, bracts enclosing spikelets with yellow flowers; female sparingly branched, a few yellow flowers, start at 15-year age; November–February, March–May. *Fruit*—large, 15–20 cm in diam, enclosed by the enlarged perianth, distinctly trigonous when young, when old almost spherical due to fleshy mescocarp. *Pyrene*—3–1, rarely 4, endosperm edible; August–September.

Distribution and Ecology—Native to India, a grand feature in the tropical landscape. Wild in many parts of India. Also cultivated in Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Orissa, Madhya Pradesh, Bihar and West Bengal. Also found in Gujarat, Maharashtra and Assam. Found on the riverbanks, tank-bunds, field-bunds, wastelands, coastal areas, rocky areas, low sandy plains at the sealevel under the tropical sun and monsoons; acts as windbreak for plains; readily forms pure forests or sometimes with wild datepalm in monsoonal areas. Grows on every type of monsoonal soil in the tropical areas; does not give much shade.

CULTIVATION/REGENERATION

Natural Regeneration—Direct sowing; seeds grow under favourable conditions; if seedlings are protected, pure patches can be grown.

Artificial Regeneration—Easy to reproduce artificially. Several pests have been reported.



Borassus flabellifer

UTILIZATION

Reclamation—Recommended for agro- and social forestry and shelter-belts in coastal sand-drift areas; for field-bunds, riverbanks, wateredges, wastelands and various types of soils to prevent erosion. Leaf useful to reclaim saline and alkaline soils, and for green-manuring paddy. Every part is useful.

Timber—Trees felled at 50–60 years which are past the stage of tapping.Pillars, posts, poles, foot-bridges, fencing, house-building, gutters, water-channels, rafters, canoes, umbrella-handles, walking-sticks, paper-rulers, fancy boxes, picture-frames, etc.

Fuel—All parts are used.

Fodder—Soft, pithy portion a good animal feed. Sometimes leaf fed to cattle (protein, 12.1%).

Others—Bud: Bud or cabbage is a delicacy; nutritive, tonic, diuretic. *Leaf:* Fancy articles, fans, mats, hats, bags, umbrellas, buckets, receptacle for liquids, baskets, flutes, toys, leafrope, fencing, raincoats, thatching, fishtraps; bleached and coloured used for diaper articles. In ancient times used for writing with an iron-stylus. *Fibre:* Midrib used for brooms in mechanical sweepers; large quantities exported. *Bases of Leafstalk*: Used for brushes.

Petiole: Highly fibrous; extracted fibres processed, classified, exported, known as BASSINE; suitable for ropes, brushes of various types, brooms, twines, fencing, sandals, doormats, mats for packing, cushions, baskets, hats, etc. ; also for lacing cots, chairs, cattleyokes, fishtraps and other agricultural purposes; suitable for pulp.

Inflorescence: Spadices yield, on tapping, a sweet, delicious liquid, called SWEET TODDY, extensively consumed as a supplementary diet; contains iron and other minerals, ascorbic acid, vitamin-B complex; cooling, diruetic, stimulant and digestive; excellent source for biologically available riboflavin; ferments to an alcoholic beverage; source of vinegar. Made into jaggery; it is more nutritious than cane-sugar, used for convalescing patients; probably useful in hypertension and oedema. An antibilious sugar also produced; alterative; used in hepatic disorders; a candy is made out of it.

Molasses: Used in preparing aerated waters, confectionery syrup, palmolates, etc. Contains protein (4.5%), vitamin-B and -C.

Fruit: Soft, jelly-like, endosperm eaten with sap; a cooling, delicious food; tender kernels canned in syrup; mesocarp of ripe fruit contains soft, luscious, sweet, syrupy, farinaceous pulp; ripe fruit roasted and pulp eaten; also mixed with flour, coconut, banana, milk, sugar, etc. Several delicious sweets prepared; germinating fruits develop a sweet, pleasant, cheese-like edible substance. Juice of ripe fruit syrupy and eaten; dried into a soft *Papad* and eaten. *Seedling:* Contains a tasty starch; roasted and eaten. Animals also eagerly devour them.

BOSWELLIA Roxb. ex Colebr. (*Burseraceae*)

Balsamiferous trees and shrubs; tropical Asia and Africa; 2 spp in India.

B. serrata Roxb. ex Colebr. syn. **B. glabra* Roxb. INDIAN OLIBANUM TREE, INDIAN FRANKINCENSE TREE

Beng &Hindi–*Kundur, salai;* Guj–*Dhup, gugali;* Kan–*Guguladhupa;* Mal & Tam–*Parangisambranani;* Mar–*Salai;* Oriya–*Loban;* Sans–*Ashvamutri, shallaki;* Tel–*Phirangisaambraani.*

Gonda–*Borsalla;* Santal–*Salga;* TRADE–*Salai.*

Habit—A tree, up to 18 m/2.4 m. *Bark*—greenish-grey, yellow or reddish, fairly thick, smooth, exfoliating in thin, papery flakes, resinous inside. *Leaf*—imparipinnate, 30–45 cm long: leaflets 2.5–6.3 cm × 1.23–3.0 cm, ovate, ovate-lanceolate. *Flower*—small, white, in axillary recemes or panicles; January–April. *Fruit*—trigonous, 12 mm long drupe, splitting along 3 valves; May–June. *Seed*—compressed, hard, winged; 14,700/kg; germination 0–30%; April.

Distribution and Ecology—Common from the foothills of Himalayas to Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Bihar, Orissa, Andhra Pradesh and further South. Pure forests very common in Maharashtra, Madhya Pradesh and Andhra Pradesh. Prefers dry, hot exposures of rocky hills, with 50–125 cm rainfall, especially volcanic traps. On poor and shallow soils or with ferruginous forms pure or nearly so. In the Himalayas, found on dry, sandstone ridges with species of *Acacia* and *Ziziphus*. In Rajasthan, found pure or mixed on the drier ridges. Reaches fair dimensions where others stunted.

Silvicultural Characters—Usually gregarious, comparatively in open forests. A strong light-demander. Frost-tender. Withstands fire. Produces rootsuckers. Coppices and pollards.

CULTIVATION/REGENERATION

Natural Regeneration—Occurs from seed and rootsucker; usually good even on the poorest soils.

Artificial Regeneration—Through large cuttings planted in the rainy season; even in drought the cuttings reported to root well. A few borers and beetles attack the wood.

UTILIZATION

Reclamation—Valuable for afforestation. Can be grown in semi-rocky or rocky soils in dry zones, on dry sandstone ridges; grows on drier ridges of metamorphic rocks in Rajasthan; can be planted for shelterbelts, windbreaks and hedges.

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* Treated by some as an independent species or as a variety of *B. serrata.*

Boswellia serrata

Timber—Plywood, veneers; ceiling-wall; hardboards, planking; cheap furniture, cooperage, cheap boxes, packing-cases, barrels, wells, water-pipes, hookah-stems, sheaths for knives and swords, toys, carving, boat-masts, matchsplints, ammunition boxes and paperpulp, nylon, and rayon.

Fuel—Yields firewood.

Others—*Bark:* On injury, exudes an oleo-gum-resin, known as INDIAN OLIBANUM or *salaiguggul;* used as incense; yields a rosin, volatile oil and gum. *Volatile oil:* Can be substituted for the turpentine; suitable for paints, varnishes, soaps, perfumes, possesses antibacterial properties. *Rosin:* Used for manufacturing a canada-balsam substitute, for soaps, paints, varnishes, lacquers and printing-inks. *Gum:* An excellent adhesive used in incense-sticks, distempers, calico-printing and in textile industry for sizing and finishing. Useful in diarrhoea, dysentery, etc.; defatted extract of gum anti-inflammatory and anti-arthritic; also has cholesterol- and triglyceride-lowering activity. A nonphenolic fraction possesses antitumour activity. Also yields tannins (9.1%). *Leaf:* Yields an essential oil; possesses antifungal activity. *Flower:* Eaten. *Seed:* Eaten (crude protein, 9%).

BRACHIARIA Griseb. (*Poaceae*)

Annual or perennial grasses; warmer parts of the world; 19 spp occur in India.

Many are pasture-grasses.

B. brizantha (Hochst. ex A. Rich.) Stapf LARGE-SEEDED MILLET-GRASS

Habit— A variable, perennial grass. *Culm*—up to 2 m. *Leaf*—glabrous or hairy, 40 cm × 16 mm, coarsely scabrid, partly crinkled. *Inflorescence*—racemes, spikelets 4–6 mm, glabrous or shortly hairy towards the apex, glumes unequal.

Distribution and Ecology—Native to tropical Africa, introduced into India from Australia for fodder; cultivated throughout the year under irrigation. Can be grown as pasture in coconut plantations. Rapidly covers the soils in the early spring and summer. Forms thick cover on various soils.

Cultivation/Regeneration—Propagated from seeds and rooted stocks or stem-cuttings; fertilizers improve the growth; growth is vigorous throughout the year under irrigation even in dry season; hardly tolerates any weeds; 4 or more cuttings can be taken; yield *c.* 51 tonnes/ha under trials.

UTILIZATION

Reclamation—Can be grown for erosion-control, particularly in dry zones due to its adaptability. Useful for protecting the bunds of newly formed terraces, and for soil-conservation. Fairly drought- and cold-resistant.

Fodder—Promising pasture (protein, 9.38%), relished by cattle. Suitable for all areas, with high productivity, particularly dry zone. Good hay and silage can be made; suspected to cause the death of sheep when grazed on pure stands in Australia. Tolerates cutting and grazing.

B. distachya (Linn.) Stapf syn. *Panicum distachyon* Linn.; Hook. f. (Fl Br Ind) in part.

Hindi–*Motia;* Kan–*Hambuharakahullu;* Tel–*Korannagaddi.*

Habit—Herbaceous grass. *Stem*—30–60 cm, straggling or creeping below. *Leaf*—5–15 cm × 3.2–6.2 mm flat. *Spike*—erect, 2.5–10.0 cm long, spreading. *Spikelet*—variable, pale green.

Distribution and Ecology—Throughout India in plains as a weed in waste places and in cultivation. Also reported from the Aka hills of Arunachal Pradesh. Prefers inundated fields and riverbanks.

UTILIZATION

Reclamation—Can be employed as a soil-binder.

Fodder—Cultivated in Australia for fodder and hay; relished by animals and fatten on it.

B. mutica (Forsk.) Stapf syn. *Panicum muticum* Forsk.; Hook. f. (Fl Br Ind) in part; *P. purpurascens* Raddi ex Nees, non Opiz PARAGRASS

Beng–*Nardul;* Kan–*Mauritiushullu;* Mal–*Colombupullu;* Tam–*Neeradipul.*

Habit—An aquatic perennial, up to 2.5 m. *Stem*—hollow, rooting at nodes. *Leaf*—ovate-lanceolate, 12–30 cm long, glabrous, scabrid. *Inflorescence*—numerous racemes, 2.5–9.0 cm long, in erect panicles; spikes rather distant, stout, simple or divided below; spikelets turgid, greenish or purplish; seed sparce.

Distribution and Ecology—Native to South America and West Africa, introduced for fodder into tropical and subtropical India having medium to heavy rainfall. Extensively cultivated in Maharashtra, Karnataka, Kerala, Tamil Nadu, Bihar, Assam and Manipur, Punjab, Uttar Pradesh and Orissa. A water-loving grass, naturalized near swampy grounds and near sewage-farms and other moist areas. Suited to warm, humid climate in tropical and subtropical India, but sensitive to cold. Once established it continues to grow for more than 10 years. Grows on a variety of soils from sticky, deep-black soils to light and shallow soils. Can grow on saline and alkaline soils with a *p*H 8–9.

Cultivation/Regeneration—Sparingly seeds. Can be grown near waterlogged areas. Generally established from mature stem-cuttings of 20–30 cm long, with 2–3 nodes, or from rooted runners; cuttings establish in 6 days. Once established continues to grow for over 10 years. Under irrigation, the grass can be planted at any time but, under rainfed condition, planting should be done with the onset of monsoon or in cool months. A spacing of 30–45 cm and planting 1-node deep are employed; 15 cm spacing is given for a thick stand. Responds to heavy manuring (farm-compost or sludge, 9–61t /ha) and fertilization (178 kg ammonium sulphate) after each cutting. Can be grown along with cowpea (*Vigna ungiculata*) and vetch (*Vicia sativa*). Field lightly ploughed each year and weeds removed. Essential to keep the ground moist during dry months to keep the grass green all round the year. First cutting after 3 months and 6–15 cuttings can be taken a year. Generally free from pests and diseases. Yield 37–50t /ha; up to 330 tonnes were reported.

UTILIZATION

Reclamation—Can be used for conservation of soil and reclamation of saline and highly alkaline soils, swamps, seepage-affected and newly cleaned areas, as also low lands. A good cover-crop and prevents soil-erosion.

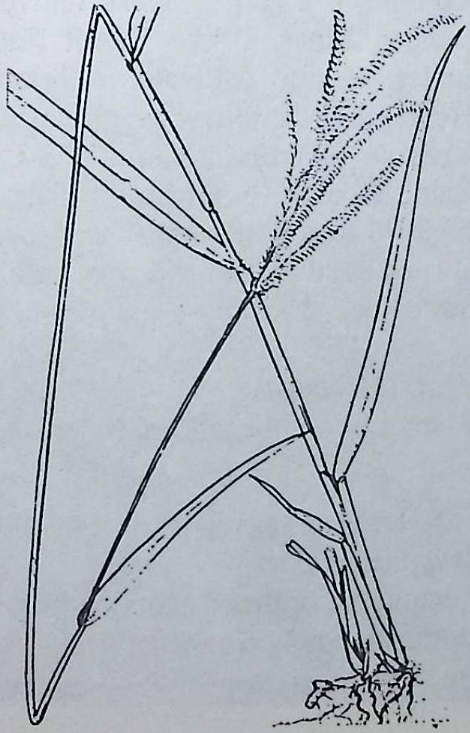
Fodder—Grass (protein, 15.75%) remains tender and is highly succulent, palatable and nutritious and can be fed even without chaffing. Can be mixed with feeds and molasses and mineral mixtures. One of the best grasses for milk-cattle and horses.

B. ramosa (Linn.) Stapf syn. *Panicum ramosum* Linn.; Hook. f. (Fl Br Ind) in part

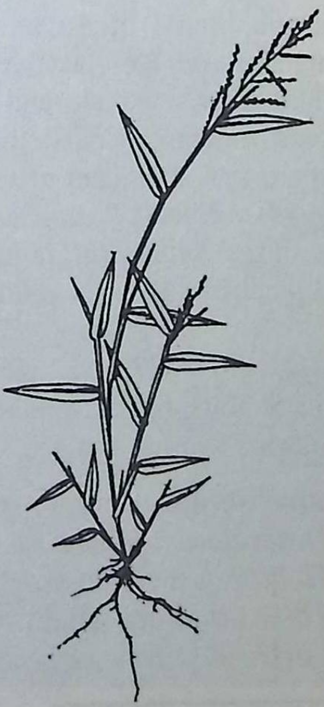
Hindi–*Makraghas;* Kan–*Bennaeaḳkehullu;* Mal–*Champothaval;* Mar–*Dhangli;* Tel–*Eudurigaddi.*

Habit—An annual or often perennial grass. *Stem*—decumbent, branched below. *Leaf*—lanceolate, 7.5–10.0 cm × 0.6–2.5 cm, thin with glabrous or pubescent sheath. *Inflorescence*—a panicle, 5–15 cm long. *Spike*—2.5–5.0 cm. *Spikelet*—ellipsoid, pale green, alternate, often in pairs.

Distribution and Ecology—Wild throughout the greater part of India, commonly in moist localities. Also, cultivated in parts of Andhra Pradesh, Karnataka, Maharashtra and Rajasthan. Also found in mixed xeromphic



Brachiaria brizantha



B. ramosa

thorny forest with 350–750 mm rainfall in Rajasthan, and on deep sandy soils in arid areas.

Cultivation/Regeneration—Short-duration crop of 3 months; sown from late August to mid October and harvested before the end of December. Yields grain (5.5 qt/ha under irrigation and 3.3 qt/ha under drier situations) and straw (*c* 5.5 qt/ha).

UTILIZATION

Reclamation—Can be grown in Rajasthan, especially as pasture.

Fodder—Best fodder (crude protein, 3.40–14.58%); relished by cattle; improves the yield of milk.

Others—Seed: Superior to little millet (*Panicum sumatrense*) and eaten as pudding.

B. decumbens Stapf is a fairly drought-resistant, perennial grass, native to tropical Africa, introduced into India for pasture, reported to be growing well. Vegetatively propagated. One of the best grasses for permanent pastures or leys. *B. deflexa* (Schum.) C. E. Hubbard ex Robyns is also a drought-resistant grass and a good palatable fodder; its grain is eaten. *B. lata* (Schum.) C. E. Hubbard, a quick-growing, leafy grass, introduced into India for conservation of soil and fodder for livestock. *B. miliiformis* (Presl. ex C. Presl.) Chase syn. *Panicum distachyum* Hook. f. (Fl Br Ind) in part (TWO-SPIKED PANIC; Kan–*Kaadusamedhullu*) is a slender grass, native to Australia, found in Assam, West Bengal, Bihar, Orissa, Tamil Nadu, Karnataka and Kerala. Excellent fodder, easy to cultivate, withstands drought, tolerates shade, and reported to improve the soil; when grown with coconut, increases yield of the nuts. *B. reptans* (Linn.) C.A. Gardner & C.E. Hubbard syn. *Panicum prostratum* Lam.; Hook.f. (Fl Br Ind) in part; *P. procumbens* Nees; *P. ramosum* Hook. f. (Fl Br Ind) in part; *P. umbrosum* Retz. (Tam–*Shanipillu)* is found as a weed in cultivated and waste places of tropical India. It is a good fodder for cattle.

* BROUSSONETIA L' Hérit . ex Vent. (*Moraceae*)

Dioecious, laticiferous shrubs and trees or climbers; Eastern Asia and Polynesia; 3 spp in India.

B. papyrifera L' Hérit. ex Vent. PAPER-MULBERRY, TAPA-CLOTH TREE

Hindi–*Jangli toot;* Kan–*Kaagadauppunaeralae.*

Habit—A medium-sized, fast-growing, but brittle, deciduous tree, up to 21 m/2.1 m. *Bark*—light grey, smooth, shallowly fissured. *Leaf*—variable, obliquely ovate or oblong, entire to variously lobed, 7.6—20.0 cm.

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* Includes *Allaeanthus* Thw.

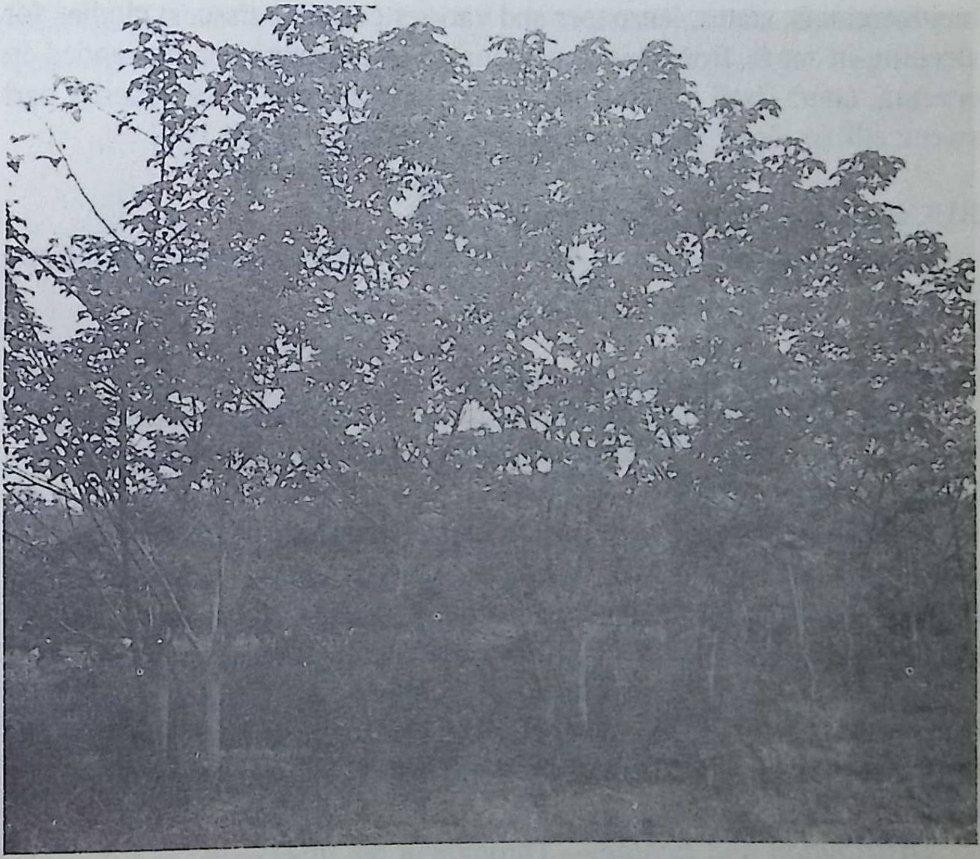
Flower—unisexual: male in cylindric catkin; female in globose head; starts within 2 years. *Fruit*—fleshy, red, shining, compound achenes, on fleshy stalks; ripening improves vigour and germination. *Seed*—5,387,100/kg; April; germination 15 days.

Distribution and Ecology—Native to Eastern Asia, introduced into India, from Punjab to Arunachal Pradesh and Meghalaya extending into peninsular India from sealevel up to 1000 m, with a rainfall of 1800 mm. Light, moist, but well-drained sandy-loam soils best-suited; stiff clay and hard laterite soils prevent root-growth.

Silvicultural Characters—Sensitive to root-competition. With heavy grass on poor ground does not grow. Produces rootsuckers. Coppices well. Eagerly browsed which results in bushy growth. Monkeys, birds and rodents cause extensive damage to fruits.

CULTIVATION/REGENERATION

Natural Regeneration—Profusely regenerates from seed and rootsuckers; once established, rapidly spreads and becomes a weed.



Broussonetia papyrifera

Artificial Regeneration—Easy to grow from seed, transplants, cuttings and stumps. Direct sowing gives good results but transplants and stumps safer; air-layering gives promising results. Seedlings transplanted at 1.8 m asunder; weeding and thinning essential. Planting of many male trees is required which can be obtained through vegetative propagation; attains 2 m in first year.

UTILIZATION

Reclamation—A very useful soil-binder; can be grown in gullies and ravines to prevent erosion.

Timber—Suitable for newsprint, viscose rayon (cellulose, 59.2%), plywood, furniture, toys, building-boards, pencils, match-splints, etc.; burnt for lampblack for ink; contains rubber (0.6%). Acetone extract exhibits antimicrobial activity.

Fodder—Leaf good forage for cattle; suitable for feeding silkworms.

Others—Bark: Yields a strong, lustrous fibre; used for paper-making; also used for high-grade leathery paper, umbrella-covers, paper-lanterns, handkerchiefs, slates, lenspaper and various cosmetic tissues; clothes for sleeping-in made from this paper; makes good rope. Recommended in eczema. *Leaf:* Used in indigestion and as diaphoretic. *Fruit:* Fleshy part sweet, edible. *Seed:* Tonic and diuretic; yields an oil (30.1%).

BUCHANANIA Spreng. (*Anacardiaceae*)

Shrubs and trees; tropical Asia, Australia and the Pacific Islands; 6 spp in India.

B. lanzan Spreng. syn *B. latifolia* Roxb. ALMONDETTE TREE

Beng–*Chironji;* Guj & Mar–*Charoli;* Hindi–*Achar;* Kan–*Murkali;* Mal–*Mungapera;* Oriya–*Charu;* Sans–*Priyalam;* Tam–*Morala;* Tel–*Saara-* or *mortichettu.*

Habit—An almost evergreen, moderate-sized tree, with straight, cylindrical trunk, up to 15 m and tomentose branches. *Bark*—rough, dark grey or black, fissured into prominent squares, 1.25–1.75 cm thick, reddish inside. *Leaf*—thickly coriaceous, broadly oblong, obtuse, base rounded. *Flower*—small, greenish-white, in axillary or terminal panicles; January–March. *Fruit*—ovoid or globose, black; drupe, 8–12 mm in diam; April–June. *Seed*—hard stone, oily; 4300–5300/kg; germination fresh seed 70%.

Distribution and Ecology—Throughout the drier parts, and the sub-Himalayan tract, up to 1200 m, except in arid regions of North-West India;

also common in peninsular India. Found in dry, deciduous forests, and a common associate to *sal* and occupies lower canopy. Abundant on clayey and laterite soils, but not on waterlogged soils.

CULTIVATION / REGENERATION

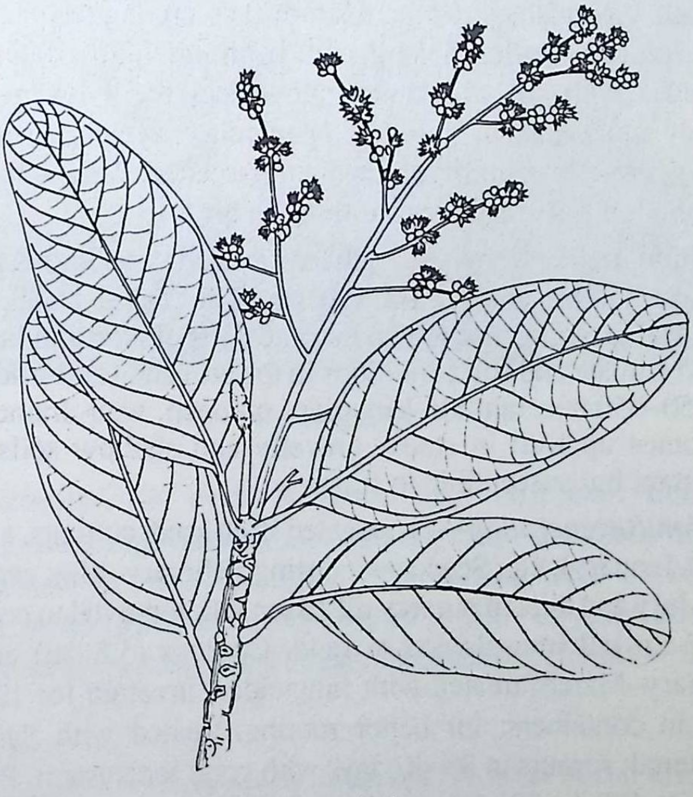
Natural Regeneration—Freely regenerates under favourable conditions provided the seed is quickly covered; radicles may dry up or damaged by insects. Part of natural regeneration is from rootsuckers on hilly ground where the roots are liable to be exposed.

Artificial Regeneration—Fresh seed or seed not exposed to the sun should be sown direct for better success than transplanting from the nurserybed. Transplanting is done during the first or second rains. Also grown along with agricultural crops.

UTILIZATION

Reclamation—A useful tree for clothing the dry hillsides, and valued for the rapidity with which it covers bare, arid slopes. Grown in agroforestry.

A host for *kusumi* lac-insect.



Buchanania lanzan

Timber—Cheap furniture, small beams, window-frames, bedsteads, boxes, yokes; and matches.

Fuel—A medium firewood (sapwood, 4446 kcal; heartwood, 4612 kcal/kg).

Fodder—Leaf lopped for cattle, sheep and goats.

Others—Bark: Yields tannins (13.4%); used for tanning leather. Exudes a pale or dark-coloured gum; used in diarrhoea and intestinal pains; also used in dressing textiles. *Leaf:* Powder applied to wounds. *Kernel:* Nutritious and eaten raw or roasted, and substituted for almonds. Yields an oil, used as a substitute for olive- and almond-oil; may be useful for coating tablets for delayed action; applied in glandular swellings of neck; an ointment is prescribed for skin-diseases.

BURSERA Jacq. ex Linn. (*Burseraceae*)

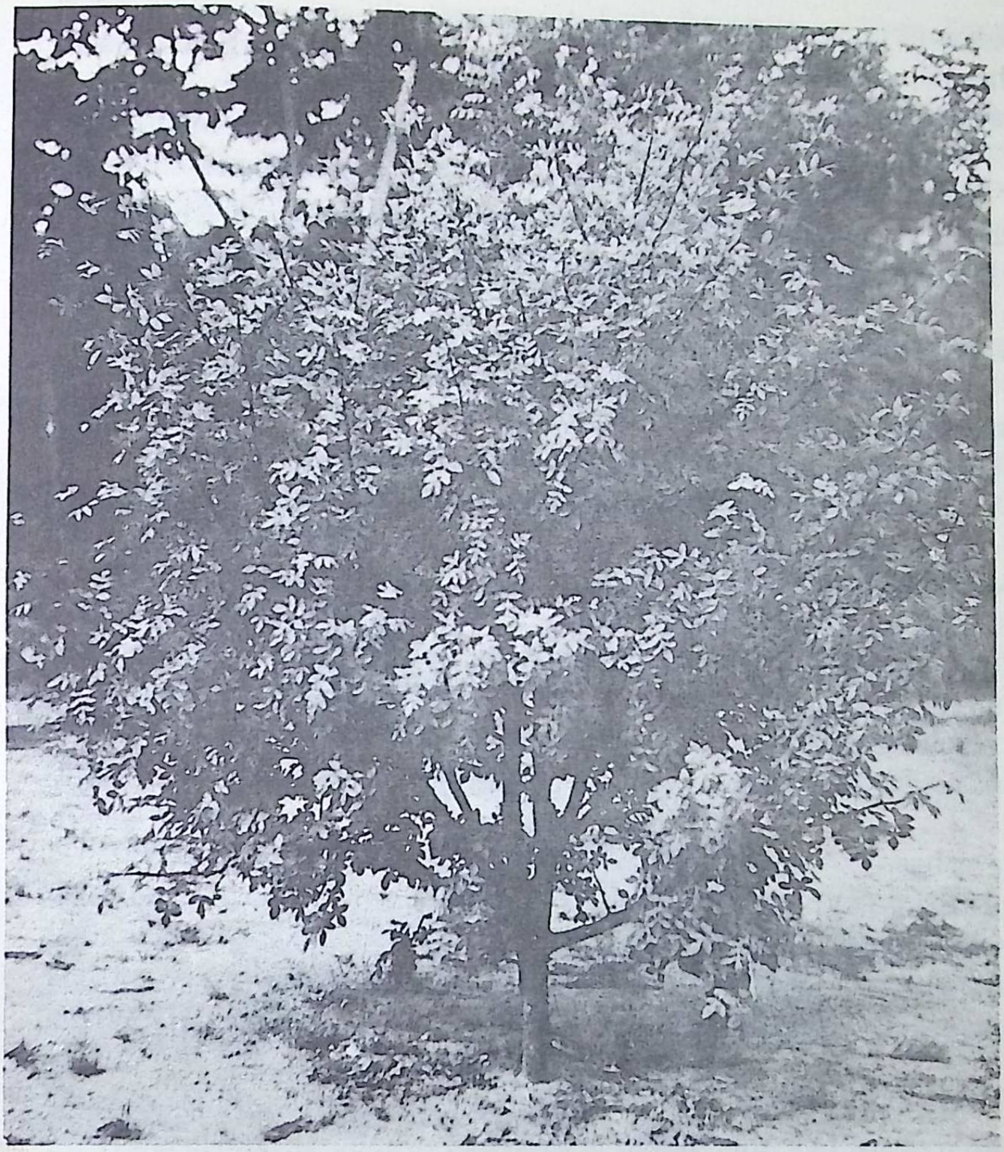
Balsamiferous shrubs or trees, native to tropical America; 1 sp cultivated.

B. penicillata (Sesse & Moc. ex DC.) Engl. syn. *B. delpechiana* Poiss. ex Engl. INDIAN LAVENDER-TREE, LIGNALOE OR LINALOE TREE

Habit—A short, bushy, highly branched, deciduous tree, up to 7 m. *Bark*—smooth, brownish, very thin, resin-ducts secreting resin on injury. *Leaf*—imparipinnate: leaflets oblong, ovoid or rhomboid, serrate, glandular on both sides, with soft, silky hairs on lower surface. *Flower*—creamy white, mainly unisexual, in branched, paniculate cymes. *Fruit*—oval, green, turning brown on maturity, 1 cm diam, 1-seeded. *Seed*—thick, hard, black; germination 5–10%; dispersed through birds.

Distribution and Ecology—Introduced from Mexico into Karnataka, now grown on 860 ha, and on a few hectares in Tamil Nadu, Andhra Pradesh and Maharashtra; also grown in some parts of North India. Grows well in varied climate and soil conditions in the arid and semi-arid regions and needs 450–650 mm rainfall. Luxuriant on deep, well-drained sandy loam and comes up well in stony, gravelly and shallow soils; hardy, drought-resistant but susceptible to frost.

Cultivation/Regeneration—Propagated from seed, cuttings, air-layering (October–January), etc. Seed sown during February–May germinates during June–July and kept in nursery till 15 cm tall; removed to containers and when 45 cm tall transplanted to field. Cuttings (5.8 cm) are made during February–March; treated with fungicides; inverted for 12–24 hrs and planted in containers; for better rooting, treated with Saradix-B; regularly watered; sprouts in 30–40 days with good rootsystem. Planted 6 m apart in pits filled with farmyard manure; Gammexane is added to



Bursera penicillata

prevent termites. For every 8 female trees one male tree is needed. Weeding, manuring, watering and pruning helpful till bearing. Legumes can be grown as intercrops. Needs protection from cattle, birds and monkeys. Seed-raised trees start yielding after 5 years but trees from cuttings bear from third year. Fruits are collected for extracting oil.

UTILIZATION

Reclamation—Highly recommended for most of the drier regions of India for reclaiming large areas of wastelands with continuous good economic returns. Can be planted on poor soils and undulating areas otherwise unsuitable for other crops; also on loam to sandy loam with gravel and pebbles.

Timber—Toys and furniture. Also yields an oil, but low in quantity.

Others—Fruit: Pericarp yields an oil (13–18%), LINALOE OIL, with delicate flavour, used in perfume as a fixative and in soap-industry; added as flavouring to food and beverages. Substituted for true lavender-oil.

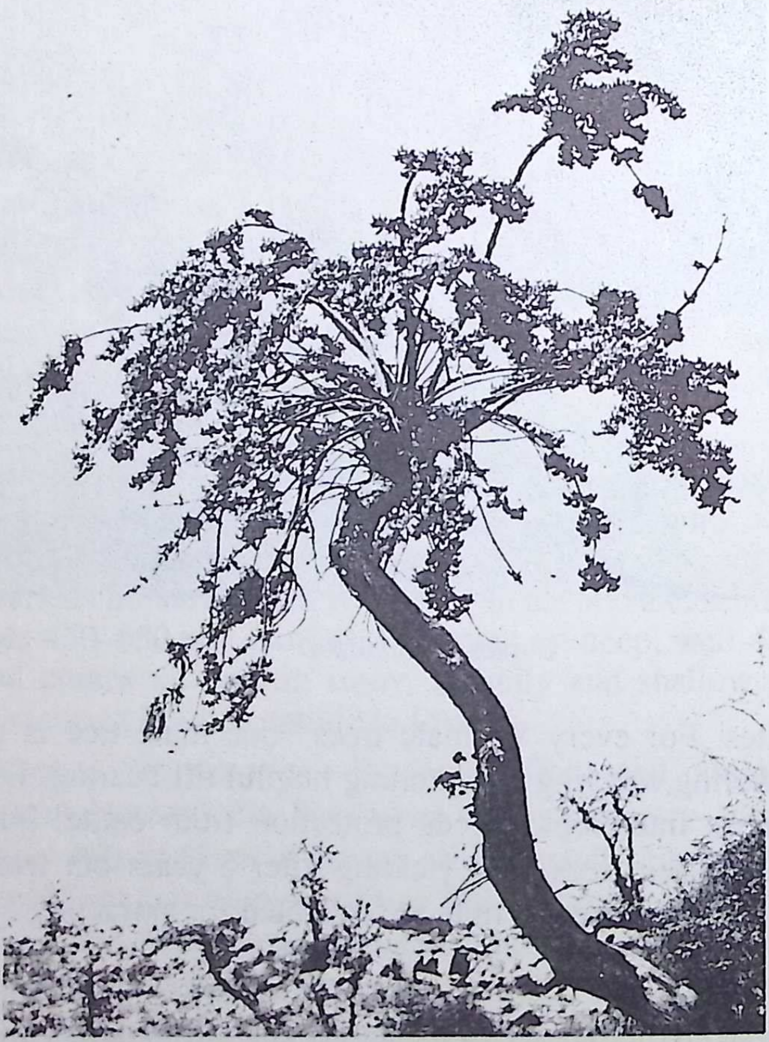
BUTEA Roxb. ex Willd. *(Fabaceae)*

Trees and lofty, woody climbers; Indo-Malaysian region and China; 4 spp in India.

B. monosperma (Lam.) Taub. syn. *B. frondosa* Koenig ex Roxb.

BASTARD TEAK, BENGAL KINOTREE, FLAME-OF-THE-FOREST

Beng, Mal & Mar–*Palaas;* Guj–*Khakharo;* Hindi & Kashmir–*Dhak;*



Butea monosperma

Kan–*Muttuga;* Oriya–*Porasu;* Sans–*Palaasa;* Tam–*Tarasa;* Tel–*Mooduga, palaasamu.*

Kol–*Morud;* Lepcha–*Lahokung;* Punjab–*Chichra;* Santal–*Murup.*

Habit—A medium-sized, deciduous tree, up to 15 m/3.8 m. *Stem*—somewhat crooked. *Bark*—bluish-grey or light brown. *Leaf*—long-petioled, 3-foliolate: leaflets coriaceous, broadly obovate from a cuneate or deltoid base, glabrascent above, with densely fine silk below. *Flower*—buds velvety blackish, flower bright orange-red, sometimes yellow, in 15 cm long racemes on bare branches; January–April, depending upon locality. *Fruit*—pendulous, silky-tomentose, 1-seeded pod, 10–20 cm × 3.7–4.0 cm; May–July. *Seed*—flat, reniform, 3.3–3.8 cm × 2.2–2.5 cm; 9850–14,790/kg; germination 7–15 days, 70–100%; viable for 12 months; fresh seed with high power of germination should be collected before rains.

Distribution and Ecology—Commonly found almost throughout India, except in arid regions, up to 1200 m. Found on inundated, swampy and waterlogged areas, open grasslands, on soils with high *p*H, saline and alkaline soils, black cotton-soils, barren lands, sand-stone, rocky refractory sites where most trees do not grow; and prefers heavy compact soil under better climate; also in *terai* and *babhar* tracts. Indicates advanced stage of degradation.

Silvicultural Characters—Withstands fair amount of shade. Very drought-resistant and frost-hardy. Produces root-suckers. Coppices and pollards well. Seedlings several times die back and recover. Immune to grazing and recovers from constant lopping and injury. Fleshy taproots are readily devoured by rats, pigs and porcupines, and young plants need protection.

CULTIVATION/REGENERATION

Natural Regeneration—Seed germinates in rains; and where moisture is plentiful, profuse reproduction occurs from seeds and suckers.

Artificial Regeneration—Direct sowing more successful than transplanting; planted in irrigated and unirrigated lines, 20–30 cm apart; for ordinary afforestation 3.0–3.6 cm spacing given; for cultivation of lac, 6 m × 6 m spacing given. Seedlings are raised at 10 cm × 10 cm in beds and transplanted during the rains after pruning; stumps also can be planted. Many field-crops are mixed with this plant.

UTILIZATION

Reclamation—Typical of grasslands; recommended for reclamation and afforestation of inundated, badly drained, waterlogged or swampy soils, black cotton, sandstone, rocky, refractory soils, and saline blanks, saline and alkaline and barren lands; and arid and semi-arid regions where most trees do not grow. Since not grazed by goats, prominently found in heavily grazed lands. Grown under agro- and social forestry.

Grown for lac-insect as a host.

Timber—Well-curbs, waterscoops, rough packing-cases; cheap boards; and paper-pulp.

Fuel—Moderate fuel (4925kcal/kg); yields a charcoal which possesses decolouring property and can be used for purification.

Fodder—Leaf (crude protein, 14.79%) lopped for feeding buffaloes.

Others—Stembark: Astringent, bitter, anthelmintic; useful in tumours, bleeding-piles and ulcers; alcoholic extracts have antibacterial activity. Yields a juice, called KINO OR BUTEA GUM, substituted for genuine kino; applied to ulcers and in sore throat; astringent and given in diarrhoea, dysentery, phthisis and haemorrhage from stomach and bladder; gum solution applied in bruises, inflammation and ringworm. Also yields a fibre and tannins (5.82%). *Leaf:* Used for platters, cups, native umbrellas and for wrapping. Astringent, tonic, diuretic; used in stomach troubles, boils, pimples, tumours, etc. *Root:* Useful in night-blindness and in elephantiasis. Yields a coarse fibre. Used for cordage and caulking boats. *Flower:* Astringent, diuretic, aphrodisiac; used as poultice for bruises and sprains; decoction given in diarrhoea; yields a brilliant, but very fugitive, yellow dye. Active against *Helminthosporium sativum*. Alcoholic extract shows anti-implantation activity. *Seed:* Aperient, rubefacient, anthelmintic, antiovulatory, abortive and antibacterial; a paste of it with lemon-juice applied to ringworm and herpes. Yields a fixed oil (20%), known as MOODUGA or KINO-TREE OIL, which can be used in soap-making; cake contains protein (20%); can be used for making plywood.

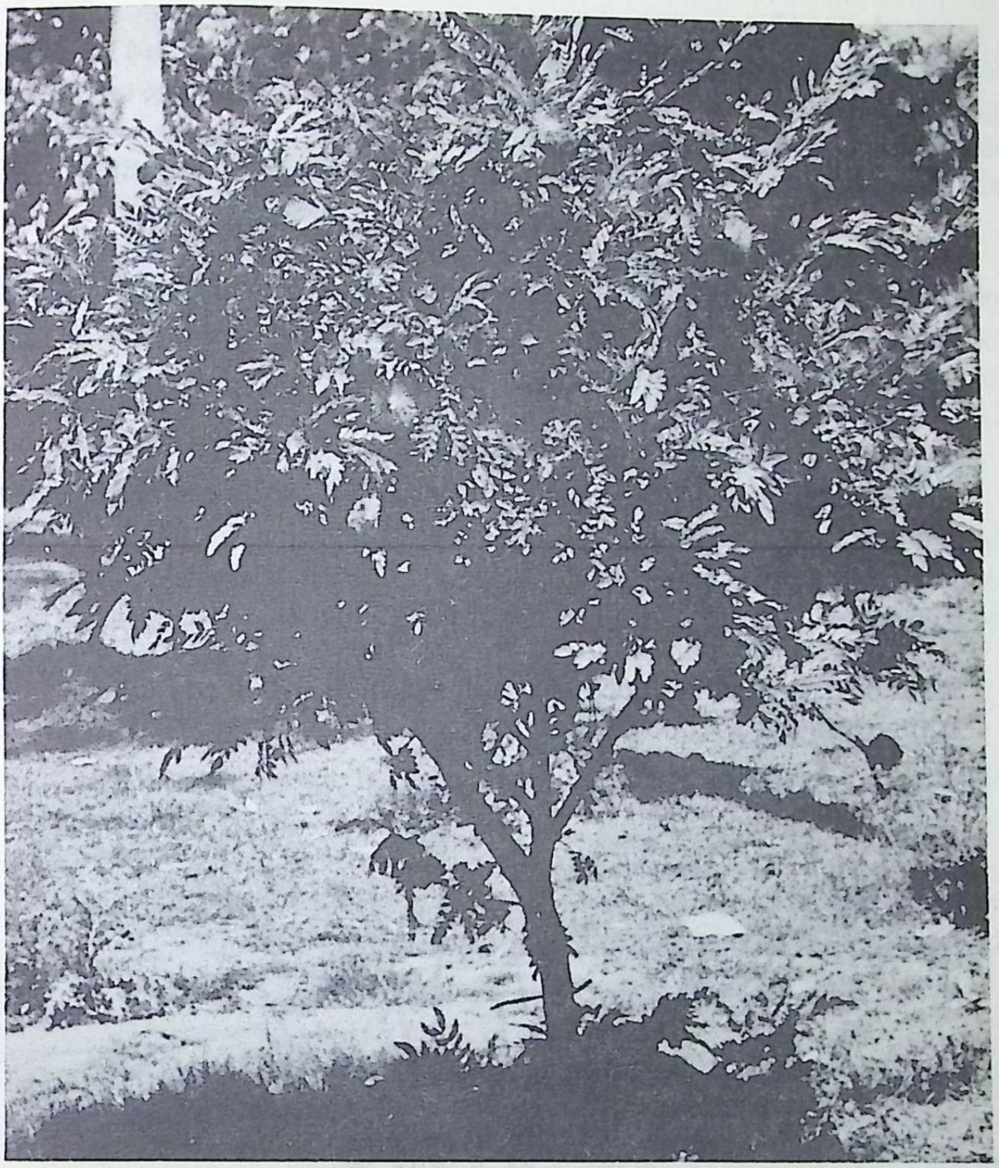
CALLIANDRA Benth. (*Mimosaceae*)

Unarmed shrubs or small trees or sometimes perennial herbs; tropical and subtropical America, West Africa, Malagasy and India; 10 spp in India.

C. calothyrsus Meissn. syn. *C. confusa* Sprague & Riley

Habit—A fast-growing shrub or tree, up to 5.4 m. *Leaf*—pinnate, 15 pairs of pinnae: leaflets many, linear, round or very obtuse. *Flower*—green, stamens red, powder-puff-like; November– March.

Distribution and Ecology—Native to Central America, introduced into India; grown for ornament. Extremely adaptable, thriving on a wide range of soils up to 1500 mm and require 1000 mm rainfall annually, but can withstand drought for several months.



Calliandra sp

Cultivation/Regeneration—Plantations are easily established from direct seeding or through seedlings.

UTILIZATION

Reclamation—Suitable for erosion-control and reclamation of eroded land and terrace-stabilization.

Fixes nitrogen and produces litter which improves the quality and productivity of soil. Hence, in East Java it is sometimes rotated with agricultural crops.

A good bee-pasture plant.

Fuel—Plantations exist in Indonesia for firewood(4500–4750 kcal/kg) mainly for domestic use and for brick-, tile- and lime-kilns, copra-dryers, and for sugar-processing operations.

Fodder—Good fodder (protein, 22%), relished by livestock.

CALLIGONUM Linn. *(Polygonaceae)*

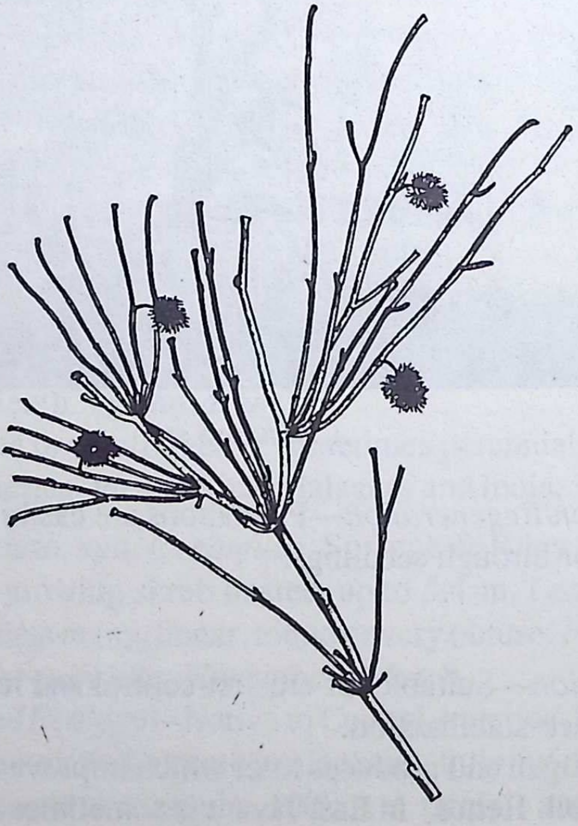
Shrubs or small trees; deserts of Asia, North Africa and southern Europe; 1 sp in India.

C. polygonoides Linn.

Haryana, Punjab & Rajasthan–*Phog*.

Habit—A slow-growing, branching shrub, 1–2 m, rarely 7 m.*Stem*—modified into phylloclades. *Leaf*—few or none, reduced, linear-subulate. *Flower*—pink, sweet-scented in axillary fascicles; May. *Fruit*—oblong reddish-brown nut, densely clothed with bristles.

Distribution and Ecology—Punjab, Haryana, Rajasthan and Gujarat. In arid parts on sand-dunes and older alluvium and on undulating topography. Resistant to drought and frost.



Calligonum polygonides

UTILIZATION

Reclamation—Easy propagation helps in afforesting and in controlling shifting sand-dunes, loose sand and the older alluvium with hammocky and undulating topography and mineral soils. Suitable for shelter-belts, hedges and windbreaks; also useful as mulch; suitable to grow on grasslands.

Twig—Employed in hut-making.

Fuel—Thick branches and rootstock used as firewood.

Fodder—Leaf: Important green fodder in deserts (crude protein, 10–15%) and eagerly browsed by camels, but not generally relished by cattle, goats, sheep; however, during flowering readily eaten. Dried shoots astringent and saltish and mixed with other roughages. *Fruit:* Nourishing feed for milch-cattle and camels; fairly rich in protein and ascorbic acid (115–378 mg/100 g).

Others—Leaf: Juice applied to eyes as antidote to the latex of *Calotropis* spp. *Flower:* Buds (protein, 18%) collected and made into a bread or salad with curd or fried and eaten; rich in vitamins and minerals; cooling; used in sunstrokes.

CALOPHYLLUM Linn. (*Clusiaceae*)

Evergreen trees; tropics of Asia, Africa, Australia and America; 7 spp in India.

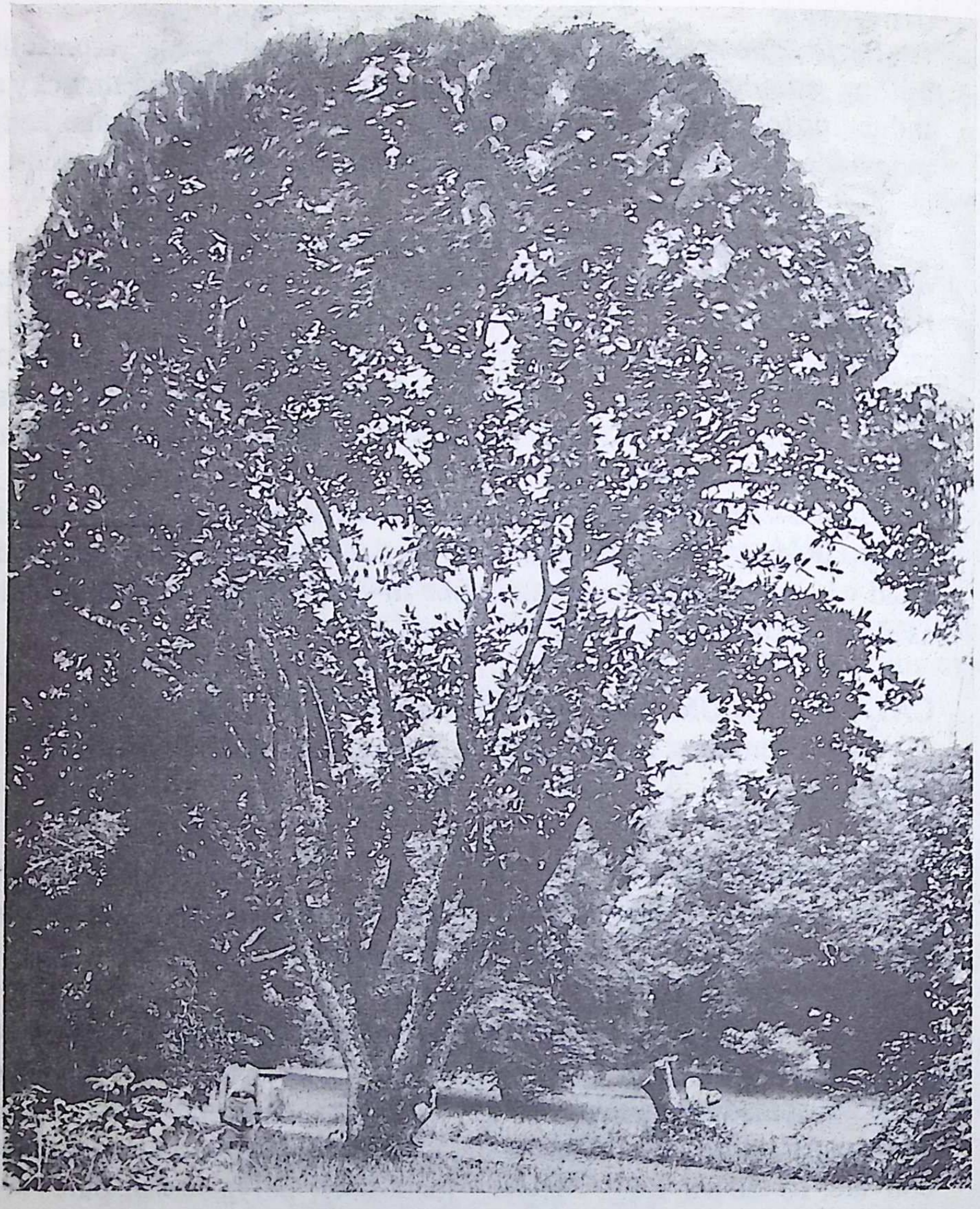
C. inophyllum Linn. ALEXANDRIAN LAUREL

Beng & Hindi–*Sultanachampa;* Guj–*Udi;* Kan–*Honne;* Mar–*Surangi;* Oriya–*Poonang;* Tam–*Punnai;* Tel–*Ponnachettu.*

TRADE–*Poon.*

Habit—A moderate- to large-sized, essentially littoral, evergreen tree, up to 20 m/1.5 m. *Stem*—stout, clear bole up to 15 m or sometimes low, crooked, spreading branches. *Bark*—pale grey, dark or blackish, smooth, with deep furrows, exuding milk. *Leaf*—broadly elliptic-oblong to ovate or obovate, 10–20 cm long. *Flower*—handsome, polygamous, pure white, delightfully fragrant, 2.5 cm diam, with slender pedicels, in few-flowered, lax, axillary racemes; February–June. *Fruit*—globular, smooth, green or yellowish drupe, red when ripe, 3 cm × 4 cm; March–July and September–November. *Seed*—glabrous, hard; 100–211/kg; germination 50–55 days, 48%, but removal of seedcoat reduces to 22 days with 93% success.

Distribution and Ecology—Grows best on deep soil near the coast and thrives on pure sand containing lime but generally poor in other minerals; on sandy coastal lateritic soils above high watermark, exposed to seawinds;



Calophyllum inophyllum

grows on detrius and on sand and shingles; grows where watertable is high with generally sweet water. Withstands xerophytic conditions.

Silvicultural Characters—A light-demander. Resists drought, but sensitive to frost and fire. Moderate coppicer.

CULTIVATION/REGENERATION

Natural Regeneration—Reproduces fairly well from seed.

Artificial Regeneration—Can be raised either from direct sowing of ripe, fresh seed, or transplanting the nursery-raised seedlings.

UTILIZATION

Reclamation—Recommended for cultivation on soils mentioned above to protect the erosion on coasts. Salt-resistant. Can be planted for shelter-belts and windbreaks in controlling sand-drift. Suitable support for pepper under social forestry.

Timber—Posts, beams, cabinet-work, furniture; and shipbuilding.

Others—Bark: Yields tannins (9.1–15.5%). Astringent; poultice for orchitis; juice purgative; possesses antibacterial activity; decoction used for dressing ulcers. *Leaf:* Piscicidal. *Flower:* Yields nectar; recommended for establishing apiaries. *Fruit:* Ripe ones eaten. *Seed:* Kernel yields an oil (50–75%); used for burning, painting woodwork and tanning; recommended as a lubricant in place of castor-oil; refined oil suitable for soap-making; possesses antibacterial and antifungal activity and two principles from it may be useful in cardiac problems. Oil possesses antibacterial properties; may be used as protectant from pulse-beetle. Used in rheumatism, ringworm, leprosy and skin affections. Calophullolide from seed is anticoagulant, anti-inflammatory and antiarthritic. Cake can be used as manure.

CALOTROPIS R. Br. (*Asclepiadaceae*)

Laticiferous shrubs or small trees, commonly known as MILKWEED or SWALLOW-WORT; tropical Asia and Africa; 3 spp in India.

C. gigantea (Linn.)Ait. f. GIGANTIC SWALLOW-WORT, MADAR

*Beng & Mar–*Akand;* Guj–*Akodo;* Hindi–*Ak*, *ark;* Mal–*Erukku;* Tam–*Erukkam;* Tel–*Peddajilleedu, jilleedudoodi* (floss).

Habit—A much-branched, hardy, woolly, erect shrub with nauseating odour, 1–5 m, sometimes up to 6 m/20–45 cm. *Stem*—woody, round, tender ones covered with soft, loosely appressed, whitish, waxy, sometimes powdery hairs. *Bark*—thick, corky, deeply fissured, friable, soft, light yellowish or ash-grey. *Leaf*—fleshy, obovate-oblong, 10–20 cm × 2.5–7.5 cm, cuneate-obovate or amplexicauled at base, mature, smooth. *Flower*—white to purple, rarely light greenish-yellow or white, in simple or compound cymose-corymbs; December–July, but all through the year in many parts. *Fruit*—fleshy, recurved, 2 or 1 follicles, second more often suppressed,

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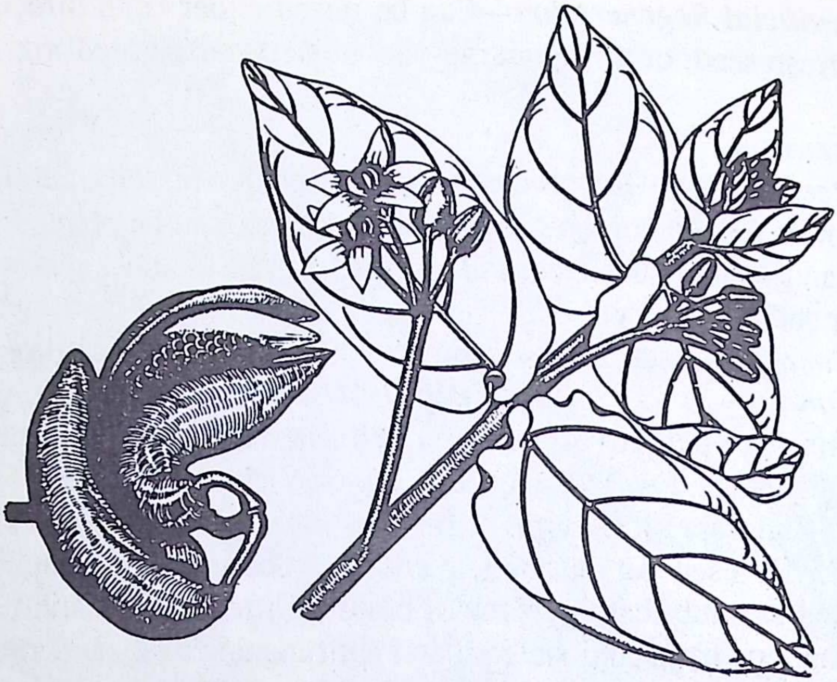
* Most of these names are also common for *C. procera* (Ait.) Ait. f.



Calotropis gigantea

7–10 cm long; February–June. *Seed*—numerous, broadly ovate, flattened, brown with long, white, silky hairs at pointed end; dispersed by wind.

Distribution and Ecology—Native to India; grows wild up to 900 m throughout India. *C. gigantea* and *C. procera* are hardy and grow on a variety of soils in differnt climates, sometimes where nothing else grows; luxuriant on rubbish heaps, waste- and fallow-lands, roadsides, ruins, rocky areas, seashores, riverbanks, sand-dunes, black cotton-soils, etc. *C. procera* grows on coarse, sandy and alkaline soils.

Cultivation/Regeneration—Both species easily grow from seeds; even root- and shoot-cuttings recommended. Need neither cultivation nor water; live for 12 years or so.

UTILIZATION

Reclamation—Both species grow on soils mentioned above and good soil-binders; highly recommended for afforestation of deserts. Eradication is difficult as the rootsystem is deep and sprouts again; suitable for shelter-belts in controlling sand-drift areas; used as green manure for betelnut, paddy and wheat; reported to correct alkalinity; compost also can be made.

Fodder—Leaf eaten by animals, but excessive ingestion of it (crude protein, 19.9%) lethal.

C. gigantea and *C. procera* closely resemble each other and similarly used. These are possible petrospecies.

Others—Stembark: Yields a durable fibre (BOWSTRING OF INDIA); useful for ropes, carpets, fishing-nets and sewing-thread. Woodash given in asthma (K_2O, 39.4%). *Stem, Young Shoots & Fresh Roots* used as toothbrushes. Used for huts and in mud-receptacles to prevent whiteants; yields charcoal used in pyrotechniques. *Latex:* All parts exude irritant latex, probably toxic; used for abortion and in dog-bite; applied to wounds, boils, ringworm; when splashed into eyes, they should be washed with water; applying atropine and chloranphenicol ointment gives relief; juice of *Calligonum polygonoides* is reported to be an antidote; dried latex used in carious teeth. Used in tanning and dyeing. Contains gigantin, which, in physiological doses, increases the efficiency of heart. Contains proteolytic enzymes and cardioactive steroids. *Leaf:* Used in fevers, rheumatism, sores, wounds and ulcers; given to cure fits and convulsions; possesses anti-implantation and anticancer activity. *Rootbark:* Applied in elephantiasis. In small doses causes nausea, vomiting and diarrhoea. Extracts showed effect on heart; ethanolic extract shows anticancer activity. *Flower:* A sweetmeat made; used in indigestion, cough, cold, eczema and asthma; possesses insecticidal and anti-implantation activity. *Seed:* Yields an oil (30.8%); used as geriatric tonic. *Floss:* Both species yield a floss inferior to INDIAN KAPOK; amenable to spinning when processed; used in mattresses, cushions, quilts, pillows, upholstery for ropes, twines and strings.

C. procera (Ait.) Ait. f. SWALLOW-WORT

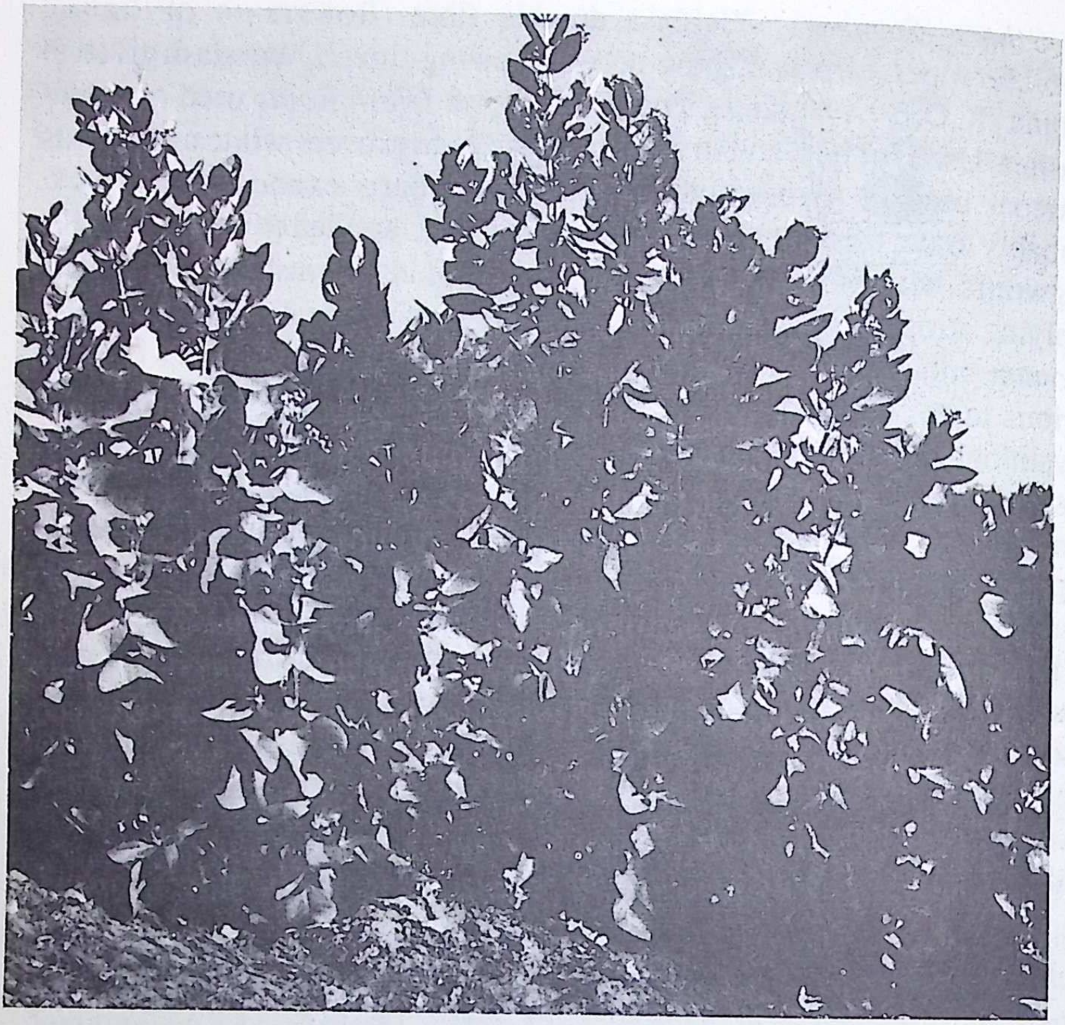
Hindi–*Akada;* Mar–*Mandare;* Oriya–*Orkho;* Sans–*Alkarka;* Tam–*Velleruku;* Tel–*Chinnajilleedu.*

Habit—A small, erect, compact shrub, covered with tomentum, up to 5.4 m/90 cm; with a clear stem of 2.4 m. *Bark*—soft, corky. *Leaf*—sub-sessile, broadly ovate or ovate-oblong, elliptic or obovate, mucronate, 5.23 cm, cottony pubescent when young. *Flower*—white to pink, scented with erect petals in umbellate cymes. *Fruit*—subglobose, ellipsoid or ovoid, recurved follicle, 7.5–10.0 cm. *Seed*—light brown, broadly ovate, flattened, 3.2 cm, with silky hairs.

Distribution and Ecology—Wild throughout India, comparatively in drier and warmer parts. Almost in similar areas as *C. gigantea,* thriving and branching better; also grows on coarse, sandy and alkaline soils and on sand-dunes.

UTILIZATION

Reclamation—Can be grown for afforestation on eroded rocky surfaces, piedmont places, old alluvial sandy soils, alkaline and saline soils,



C. procera

sand-dunes and similar to *C. gigantea*. Recommended for shelterbelts for controlling sand-drift areas.

Fodder & Fuel—Shoots used.

Others—Latex: Yields a rubber-like product, MUDAR GUMMI; contains hydrocarbons and may be useful as a renewable source of energy. Antibacterial, larvicidal, purgative and abortifacient; also used in tumours, skin-diseases, liver-swellings and piles; contains cardioactive substances and proteolytic enzyme; yields a compound calotropain which possesses anti-coagulant, anti-inflammatory and anthelmintic properties. *Shoot:* Extracts possess antibacterial and anti-implantation activity. *Leaf:* Powder useful in wound- and ulcer-healing. *Root:* Diaphoretic, antipyretic and cardiac stimulant; useful in indigestion, cold, asthma and toothache. *Rootbark:* Yields an oil; possesses antibacterial activity. *Flower:* Used in asthma, and as tonic, digestive. *Seed:* Yields an oil (23%), used as geriatric tonic.

C. acia Buch.-Ham., a bluish-grey shrub, with obovate or oblanceolate or oblong, fleshy leaves and greenish and purplish flowers, found in dry and waste places, especially on railway embankment, from Dehra Dun to Assam, up to 900 m; may be useful for preventing erosion.

CASSIA Linn. *(Caesalpiniaceae)*

Ornamental herbs, shrubs and trees; predominantly in tropical and warm-temperate regions; 40 spp in India.

Several *Cassia* spp grow in tropical and subtropical climate and thrive on clay or sand or arid soils. Many species are grown for reclamation of several types of soils. Some fix nitrogen. Generally, they are grown from seed, but layering or marcottage are also successful. Several species are grown for ornament, shelterbelts, windbreaks, shade in plantations and are recommended for agro- and social forestry, either in groups or singly, as avenue-trees, hedges, green manure, covercrops and reclamation of wastelands. Many species possess purgative and antibacterial properties. Several species yield timber, fuel, tannins, dyes, medicines, fodder, vegetables, edible fruits, coffee substitutes, etc.; seeds of a few yield a gum. Some species are: *C. alata* Linn.; *C. artemisioides* Gaud.-Beaup.ex DC.; *C. bicapsularis* Linn.; *C. didymobotrya* Fresen.; *C. grandis* Linn. f.; *C. hirsuta* Linn.; *C. javanica* Linn.; *C. leschenaultiana* DC. syn. *C. wallichiana* DC., *C. mimosoides* Linn. var. *wallichiana* Baker; *C. mimosoides* Linn.; *C. multijuga* A. Rich.; *C. nodosa* Buch.-Ham. ex Roxb.; *C. obtusifolia* Linn. syn. *C. tora* Baker (Fl Br Ind) in part, non Linn., *C. tora* Linn. var. *obtusifolia* Haines; *C. renigera* Wall. ex Benth.; *C. roxburghii* DC. syn. *C. marginata* Roxb.; *C. sophora* Linn. incl. ssp. *purpurea* (Edgew.) Bennet; *C. surattensis* Burm. f. syn. *C. glauca* Lamk.; *C. uniflora* Mill. syn. *C. sericea* Sw. Many species have several hydroxyanthraquinone derivatives which are responsible for purgative property; important ones are: emodin, aloe-emodin, chrysophanol, rhein and physion, and their glycosides and sennosides.

C. auriculata Linn. THE TANNER'S CASSIA OR SENNA

Guj & Hindi–*Aval;* Kan–*Avarike, olleetangedi;* Mal–*Avara;* Mar–*Arsual;* Sans–*Avartaki;* Tam–*Avaram;* Tel–*Merakatangeedu.*

Rajasthan–*Anwale.*

Habit—A profusely branched, tall, fast-growing, evergreen shrub, 1.2–6.0 m/21 cm. *Bark*—reddish-brown, smooth. *Leaf*—7–10 cm long, with large, auricled or rotundate-reniform, foliaceous stipules: leaflets 7–9 pairs, oblong-obovate, obtuse or emarginate, 1.5–2.5 cm × 0.9–1.2 cm. *Flower*—yellow, 5 cm diam, in terminal compound, corymbose-raceme;

October–June. *Fruit*—pale brown, oblong, 5–15 cm × 1.2–1.8 cm, flat, papery, flexible, crumpled, 6–12-seeded pod; January–June, from first year onward. *Seed*—compressed, tapering towards base; viable for 10 months; germination 15 days, 59%; may be treated in conc. sulphuric acid for 5–15 min.

Distribution and Ecology—Arid and semi-arid zones of Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh, Tamil Nadu and Kerala, up to 713 m; cultivated in some parts of Punjab, Haryana, Uttar Pradesh and West Bengal; often planted in gardens for ornament and hedges. Though evergeen, xerophytic and common in dry zone of southern, central and western India and in Uttar Pradesh; prefers red, gravelly, well-drained, lime-rich soil; also it grows on a variety of soils such as black cotton and laterite near the coast. Occurs like a weed on dry, stony hills in open places and in scrub-forests; in Rajasthan, it grows well on poor, gravelly soil and bare rocky ground; has done well on poor loamy sand with 762 mm rainfall; found on deep, sandy soils with 25–400 mm rainfall; also on sandstone, rocky, semi-rocky, refractory, flat, exposed, piedmont places, ravines, saline and degraded soils.

Silvicultural Characters—A strong light-demander; intolerant to shade or drip. Highly drought-resistant, but sensitive to frost. Profusely coppices. Needs protection from deer.

CULTIVATION/REGENERATION.

Natural Regeneration—Plenty, even on poor, shallow soil with meagre rainfall; since hardy and coppices well, it survives heavy hacking for bark and lopping of leaves for manure.

Artificial Regeneration—Ploughing before sowing helps; direct sowing yields better results than transplanting; generally June–October; may be broadcast or preferably sown in lines at a spacing of 0.9–4.2 m asunder; weeding, thinning, gap-filling and interculturing easy in lines which also stimulate growth; flooding once a month accelerates growth.

UTILIZATION

Reclamation—Recommended for afforestation and reclamation of soils in arid and semi-arid areas; a fast-growing shrub and is a very good soil-binder; can be planted in ravines, gullies, and on brackish areas, degraded lands, deep sandy soils, sand-stone, rocky, refractory sites, sand-dunes, and flat, exposed piedmont plains, highly salt-tolerant and can be planted on such soils; also recommended for shelterbelts, windbreaks for sand-drift areas. Reported to fix nitrogen; leaves used as manure to improve alkaline soils. Yields large biomass.

A good host for *Santalum album*. Extracts of seedlings show fungistatic activity.

Others—Bark: One of the best barks (TRADE–*Tangeedu* bark or *Avaram* bark) for tanning (up to 25%; av. 18%). Astringent; used for gargles in sore throat, in rheumatism, eye-disease and stomachache. If added to *Sesamum* seed during oil-extraction reported to improve the cake. Yields a fibre used for ropes. *Leaf:* Often eaten as vegetable. Anthelmintic, purgative; good for ulcers, skin-diseases and leprosy. Tea from leaves and petals given as refrigerant. Used as adulterant to senna; extract shows hypoglycaemic activity. Added as green manure for paddy as they contain nitrogen and potash. *Root:* Astringent, alexiteric, alterative; useful in thirst, urinary discharges; possesses interferon-like activity. *Flower:* Astringent, anthelmintic; used in skin-diseases, urinary discharges and diabetes. *Pod:* Anthelmintic; useful in vomiting, thirst and urinary discharges. *Seed:* Alexipharmic, refrigerant; used in conjunctivitis, gout, gonorrhoea, dysentery, cough and asthma; widely used in diabetes; extracts show hypoglycaemic activity.

C. fistula Linn. GOLDEN SHOWERS, INDIAN LABURNUM, FALSE SENNA, PURGING-CASSIA OR- FISTULA

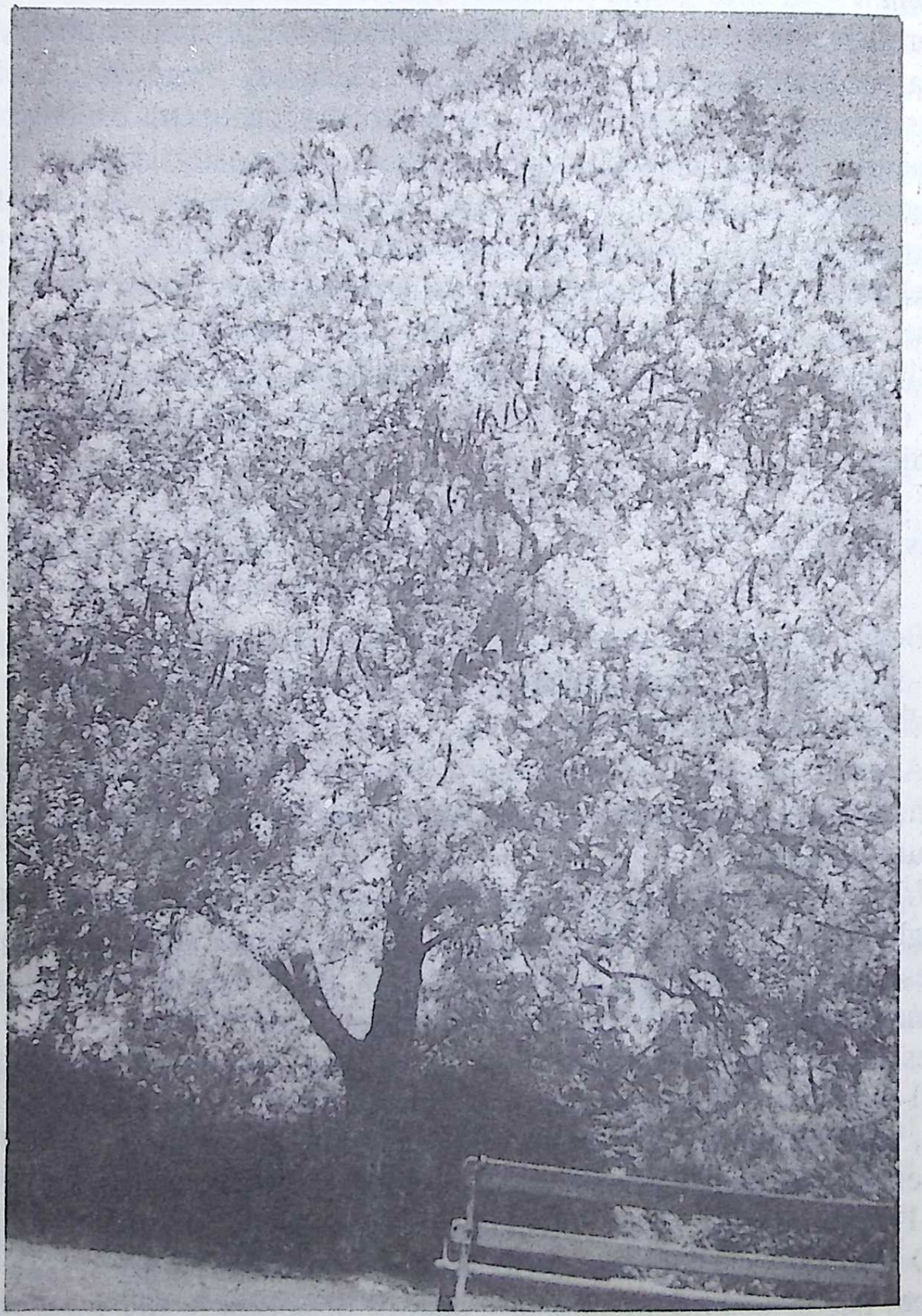
Beng, Hindi & Jammu–*Amaltas;* Guj & Mar–*Garmala;* Kan–*Aragena;* Mal–*Svarnaviram;* Oriya–*Sunari;* Sans–*Saraphala;* Tam–*Arakkuvadam;* Tel–*Reelachettu*, *koolaponna.*

Assam–*Honalu;* Garhwal–*Simara;* Jaunsar–*Kirwara;* Kumaun–*Kitola;* Lushai–*Makpazangkang;* Mundari–*Haridaru;* Punjab–*Alash;* Tripura–*Sonari.*

Habit—A deciduous, medium-sized tree, up to 24 m/1.8 m. *Stem*—straight bole, up to 15 m. *Bark*—grey, smooth, exfoliating in small, woody scales, up to 1.5 cm thick. *Leaf*—20–40 cm, glandless: leaflets 4–8 pairs, distinctly stalked, 5–15 cm long, oblong or ovate, clothed with silvery pubescence. *Flower*—bright yellow, in axillary, pendulous, lax racemes; April–July, sometimes up to October. *Fruit*—cylindric, pendulous, smooth, hard, dark brown or black, 40–100-seeded, up to 60 cm × 2.5–3.0 cm ; December–April. *Seed*—light brown, hard, smooth, shiny, 0.7–1.0 cm × 0.5–0.7 cm, biconcave, embedded in sweetish pulp; 2600–7100/kg; germination 6–52 days, 22–60%; viable for a very long period; needs soaking in sulphuric acid or in boiling water for 5 min or stratified or scarified to remove the seedcoat.

Distribution and Ecology—Throughout the greater part of India, up to 1200 m, with 450–3000 mm rainfall, introduced into the Andamans. Can grow in a very wide range of climatic and edaphic variations, ascending up to 1200 m in the sub-Himalayan tract; found on trap, granite, sandstone, *khurda* laterite soils; abundant in *babhar* tracts and frequently in *sal* forests; also on grazing-grounds and areas with brackish water.

Silvicultural Characters—A light-demander but withstands moderate



Cassia fistula

shade. Drought-hardy but not frost-hardy; frost kills young seedlings up to ground-level but sprout again. Produces rootsuckers. Coppices well. Weeding essential till properly established.

CULTIVATION/REGENERATION

Natural Regeneration—Seeds germinate during first or second or even third rains; and if burried have protection from animals and the sun. Much is through rootsuckers, particularly on hillsides, in cuttings, and places where exposed; in spite of repeated fires and trampling they survive; frost-killed plants also sprout again. Since goats do not touch, they appear on grazing-grounds.

Artificial Regeneration—Direct sowing, entire transplanting of nursery-raised seedlings or stump-planting are practiced. In dry, arid regions, mixed sowing with other species preferred; entire transplanting and stump-planting from 1–2-year-old, nursery-raised seedlings are also recommended. For transplants, seed is sown in nursery-beds 25 cm apart in March or April and watered; starts germinating in early rains, though sometimes delayed; seedlings sensitive to weeds; 15–30 cm seedlings can satisfactorily be transplanted. Transferring the seedlings to baskets in the first rains and later to arid localities result in better survival. A few fungi have been recorded; also a spike disease was reported; a few defoliators, wood-borers and bark-eating caterpillers have been recorded.

UTILIZATION

Reclamation—Recommended for reclamation and afforestation of arid and semi-arid areas, gullies and ravines, areas with brackish water, hill-sides, cuttings and landslips. Excellent for agro- and social forestry. Reported to fix nitrogen. Used as green manure.

A host for *Santalum album*.

Timber—Suitable substitute for teak and *sal*. Agricultural implements, cart and its parts, pounders and mortars, presses, poles, tool-handles, high-class furniture, and boat-building; and paper-pulp. Woodash employed as caustic to open abscess.

Fuel—Grown in plantations for fuel. Excellent fuel and yields first-class charcoal (5164 kcal/kg).

Fodder—Though leaves are reported not to be grazed by cattle and goat, given as fodder (crude protein, 15.6%).

Others—*Bark:* Astringent, tonic, antidysenteric; decoction given in leprosy, jaundice, syphilis and heart-diseases; extract of bark and stem shows hypoglycaemic, anti-cancer and interferon-like activity. Yields tannins (3.18%); used for heavy leather and fishing-nets; also mixed with other tannins. *Leaf:* Antiperiodic, laxative and used in jaundice, piles, rheumatism, ulcers and skin-eruptions. *Root:* Tonic, febrifugal, purgative, anti-inflammatory and antifungal; useful in cardiac disorders,biliousness, rheumatism, ulcers and boils, tubercular glands, skin-diseases, haemorrhages, ulcers and urinary disorders. *Flower:* Eaten as food; a confection is made. Astringent, purgative, febrifugal, antibilious. Extract antifungal against *Bipolaris oryzae*. *Pod & Pulp:* Pulp eaten and made into a drink; rich in protein (19.94%) and carbohydrates (26.3%); laxative and antibilious; given in diabetes and in blood-poisoning; shows hypoglycaemic, anticancer, antibacterial and antipyretic and interferon-like activity; possesses antifertility, and abortifacient and expulsion property. A CONFECTION-OF-SENNA is made with senna leaves, coriander, figs, tamarind, prunes, licorice and sucrose; used in tobacco-cakes. *Seed:* Used for making a drink. Possesses laxative, carminative, cooling and antipyretic properties; given in biliousness, skin-diseases and swellings; possesses hypoglycaemic and antibacterial activity; yields an industrial gum.

C. occidentalis Linn. COFFEE-SENNA

Beng & Tripura–*Kalkashunda;* Guj & Oriya–*Kasundari;* Hindi, Haryana & Bihar–*Kasunda;* Kan–*Anesogate;* Mal–*Karintakara;* Mar–*Kasoda;* Sans–*Kasamarada;* Tam–*Nattandagarai;* Tel–*Peddakasinda.*

Bombay–*Hikal;* Delhi–*Ban bhates;* Jammu–*Badde haedma;* Mundari–*Marangeakonda;* Rajasthan–*Chakundra, kasando.*

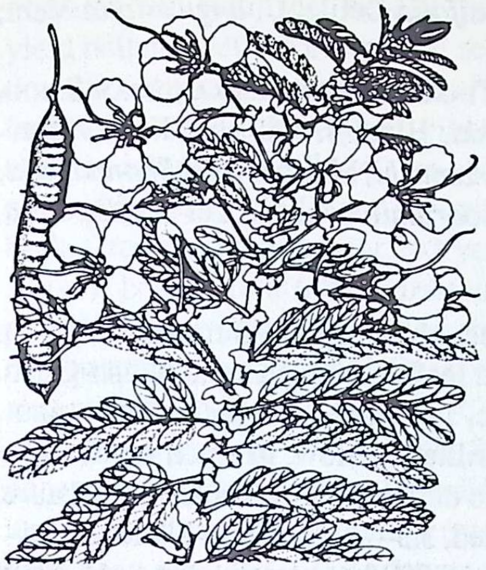
Habit—An erect, foetid, annual herb, or undershrub, 60–150 cm. *Leaf*—10–20 cm long, with caducous stipules and a black gland near base secreting nectar: leaflets ovate or lanceolate, membranous. *Flower*—yellow, in short, peduncled racemes. *Fruit*—recurved, glabrous, compressed pod, 10–13 cm × 0.8 cm. *Seed*—dark, olive-green, ovoid, 20–30, smooth, shining.

Distribution—Throughout India, up to 1400 m.

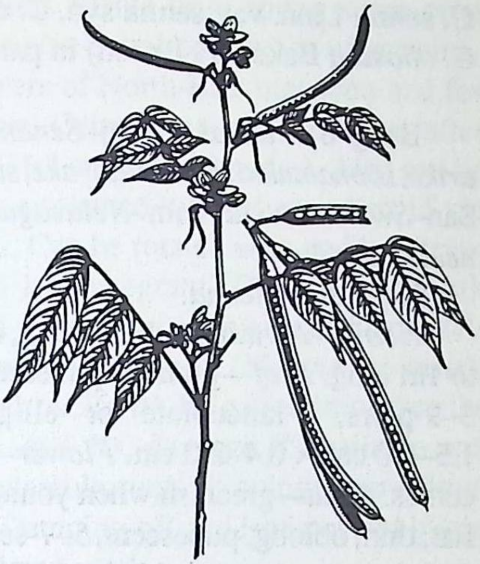
UTILIZATION

Reclamation—Recommended for various wastelands and also for green manure to restore fertility in exhausted fields. Fixes nitrogen. Often cultivated as shade-plant.

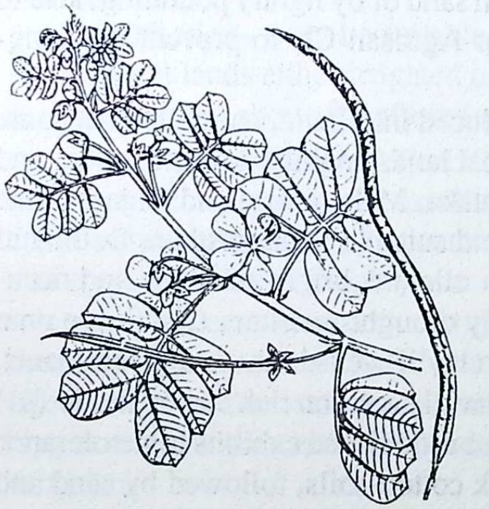
Others—Root: Tonic, purgative, diuretic, anthelmintic, febrifuge, expectorant; used in dysentery, diarrhoea, skin and liver problems; pounded with black pepper, given to nursing women. *Shoot:* Eaten as potherb (crude protein, 19.86%) and as condiment. *Pod:* Cooked and eaten. Forms ingre-



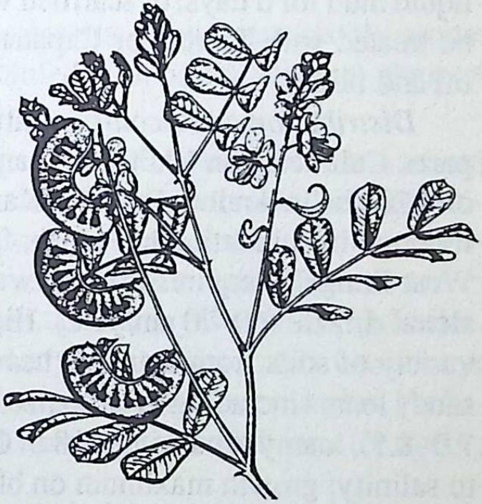
C. auriculata



C. occidentalis



C. tora



C. senna

dient of Liv52 and Geriforte. Yields an oil (2.8%). *Seed:* Immature seeds (crude protein, 35.2%) eaten; mature ones eaten during scarcity. Roasted seeds widely used as a substitute for coffee or mixed with coffee but roasting destroys purgative property. Febrifuge, antibilious, purgative, diuretic, blood-tonic and expectorant; used in skin-diseases, diabetes, leprosy, jaundice, pleurisy and whooping-cough. Seed is reported to be prophylactic against leucorrhoea. Poultice with salt applied to gunieaworm sores, inflammation, rheumatism and wounds. Used in perfumery.

C. senna Linn. var. **senna** syn. *C. acutifolia* Delile; *C. angustifolia* Vahl; *C. obovata* Baker (Fl Br Ind) in part

TINNEVELLY OR ALEXANDRIAN SENNA

Beng–*Sannamakki;* Guj–*Senamakki;* Hindi–*Hindisana;* Kan– *Nelavarike, soonamukhi;* Mal–*Nilavake, sunnamukhi;* Mar & Oriya–*Shonnamuki;* San–*Swarnamukhi;* Tam–*Nelavagai, sooratnilaavaarai;* Tel–*Neelaponna, neelatangedu.*

Rajasthan–*Senna.*

Habit—A variable, branching, erect shrub, up to 1.8 m. *Taproot*—up to 1m long. *Leaf*—pinnate, pubescent: leaflets pale green to bluish-green, 3–9 pairs, lanceolate or elliptic, varying on the same plant, 1.5–5.0 cm × 0.4–2.0 cm. *Flower*—brilliant yellow, in erect, terminal racemes. *Fruit*—greenish when young to dark brown or black when mature, flat, thin, oblong, pubescent, 5–7-seeded, 3.5–7.0 cm × 0.2–2.5 cm. *Seed*—dark brown, obovate-oblong; 14,000–35,000/kg; germination 3–15 days; soaked in water for 10–12 hrs or liquid cowdung for 24hrs and later in liquid mud for 6 days; or scarified with sand or by lightly pounding; also to be treated with Thirum or Capatan or Agrosan-CN to prevent damping-off and blight.

Distribution and Ecology—Introduced into India, naturalized in some parts. Cultivated on 10,000 ha marginal lands, mainly in Tamil Nadu, and on 2700 ha in Andhra Pradesh, Karnataka, Maharashtra and Gujarat; also reported in cultivation in Punjab; found suitable for Rajasthan, Delhi and West Bengal. Requires dry and warm climate, bright sunshine and occasional drizzle (60–70 cm/year). Highly drought-resistant. Can thrive on a variety of soils from loams to heavy clay if well-drained, dry red loams, sandy loams including even coarse, gravelly soils on rich clayey fields (*p*H 7.0–8.5), loamy sand with *p*H 8.5. Once established exhibits high tolerance to salinity; growth maximum on black cotton-soils, followed by sand and wet soils but sennosides less than that on sandy soils; waterlogging or prolonged rains not tolerated.

CULTIVATION/REGENERATION

Artificial Regeneration— Land roughly ploughed and exposed to the sun for 2–3 weeks; for dry crop after the first showers and for irrigated crop at the end of the North-East monsoon; levelled and harrowed for uniform germination; farmyard manure or compost thoroughly mixed; raised beds of 90 cm × 90 cm are made for rainfed and 3.15 m × 6.0 m with channels for irrigated crop are made; addition of BHC (10%) or Aldrin (5%) protects seedlings from white and cutworms. Roots cannot fix nitrogen; hence manures and fertilizers benefit the crop. Plants from spring-sown crop yield better-quality seed; treated seeds give better percentage of germination for a dry crop with the first showers of North-East monsoon and for irrigated crop by the end of monsoon. Generally sown broadcast after soaking rains in rows 30–40 cm apart, 1.2 cm deep (5 kg/ha). Also can be planted in nursery in December and transplanted in February when 15 cm high. Crop can continue for 2–3 years. Can be rotated with paddy (*Oryza sativa*), bengalgram (*Cicer arietinum*), horsegram (*Dolichos biflorus*), gingelly (*Sesamum indicum*) and chilli (*Capsicum annuum*); on black soils can be rotated with cotton (*Gossypium* spp*)* and mint (*Mentha arvensis*); also can be grown with coconut (*Cocos nucifera*). Irrigation improves the crop and should be given at 40–75- and 100-day age if available and depending upon moisture in soil; interculturing, thinning, gap-filling, weeding and pruning encourage crop. Damping-off and leafspot and blight have been recorded. Leaves harvested and used.

UTILIZATION

Reclamation—May be suitable for deserts; already commonly grown on marginal lands either irrigated or rainfed. Can be employed to plant on soils mentioned above for afforestation.

Others—Leaf, Flower & Pod: Purgative. Official drug and a household remedy for constipation and as a liver-stimulant. Exported in large quantities. Contain sennosides, Decoction, powder, syrup, infusion and confection are administered. Employed as tonic, febrifuge and anthelmintic and in splenic enlargement, anaemia, typhoid, cholera, biliousness, jaundice, gout, rheumatism, tumours and amoebic dysentery. Externally used in eye affections, skin-diseases, wounds and burns and to remove pimples. Probably possesses antibacterial properties. Leaves mixed with henna for dyeing hair black.

C. siamea Lamk. THE IRONWOOD TREE, THE SIAMESE SENNA

Beng–*Minjri;* Guj–*Kasid;* Kan–*Hiretangadi, simatangeedu;* Mar–*Kassod;* Tam–*Manja-konnai;* Tel–*Seematangeedu.*

Tripura–*Minjori.*

Habit—A small or medium-sized, evergreen tree, with dense crown, 6–18 m/2.8 m, sometimes up to 20 m. *Bark*—grey, nearly smooth with slight fissures. *Leaf*—12–30 cm long, eglandular: leaflets elliptic-oblong, 60 cm long. *Flower*—bright yellow in 60 cm long, axillary and terminal panicles; hot season. *Fruit*—slightly curved, flattened, soft, ribbon-like pod, purplish-brown when ripe, 15–30 cm × 1–3 cm. *Seed*—many;

37,000–45,530/kg; viable for many years; germination 10 days, 70–100%; may be treated with conc. sulphuric acid for 5–15 min or soaked in water for 36 hrs.

Distribution and Ecology—Common in tropics; from Punjab to Arunachal Pradesh and Tripura, Orissa, Madhya Pradesh, Rajasthan and Gujarat, extending into the peninsular India, up to 1200 m with a rainfall of 750–2500 mm, and in the Andaman Islands; grown in Andhra Pradesh and Tamil Nadu with success. Thrives under varied climatic and edaphic conditions in tropics, and on any kind of moist soil but well-drained, except laterite; on flat terrain and hillslopes, sandstone, rocky refractory sites and in ravines; prefers deep or shallow sandy loam.

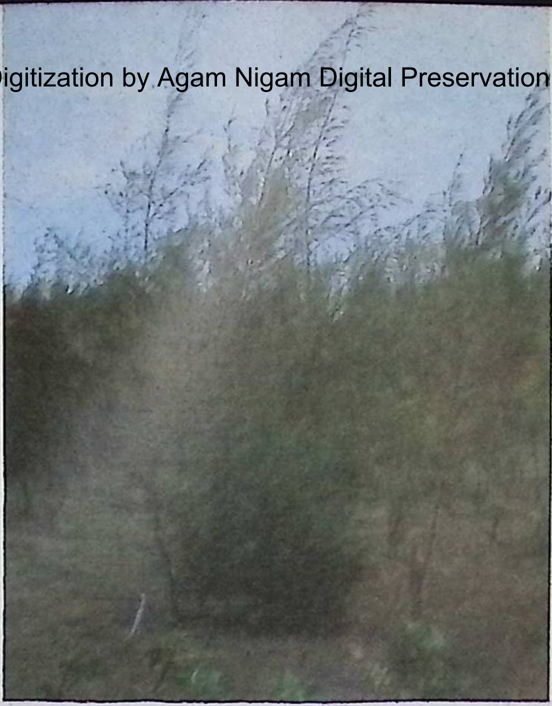
Silvicultural Characters—A strong light-demander. Drought-resistant, but frost-tender; not resistant to fire. Freely coppices.

CULTIVATION/REGENERATION

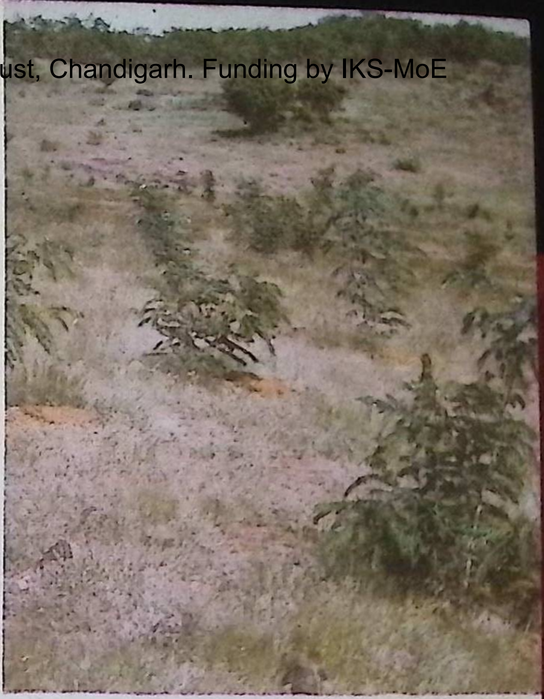
Natural Regeneration—Freely reproduces from seed. In plantations for fuel, coppice-growth is the best for regeneration.

Artificial Regeneration—Direct sowing, transplanting, stump-planting, and root- and shoot-cuttings give high success. But, generally grown from

C. siamea

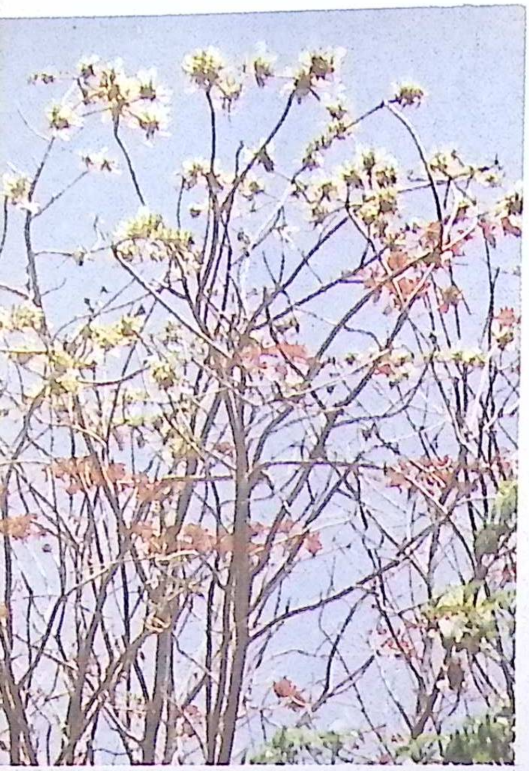


Casuarina equisetifolia

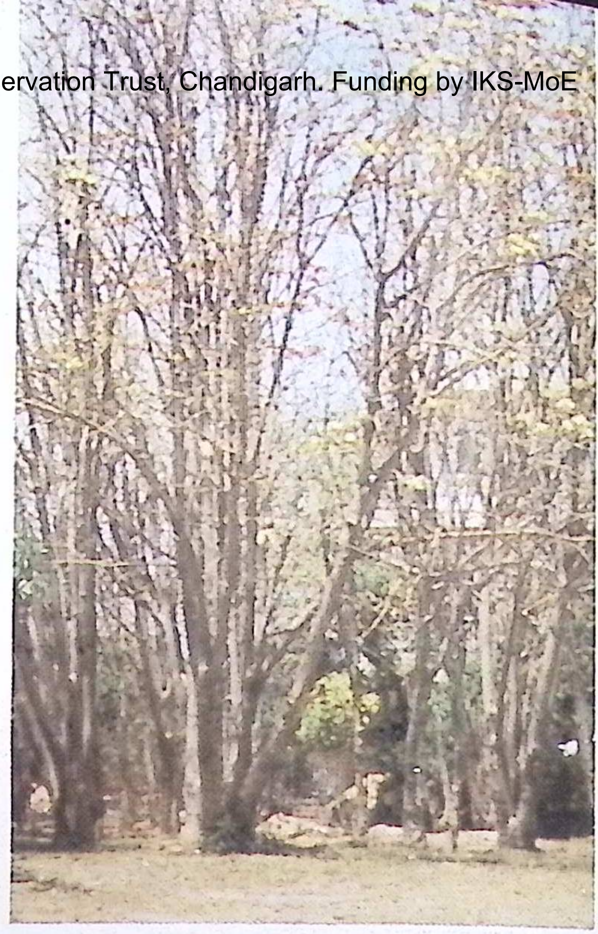


Cassia siame'a'

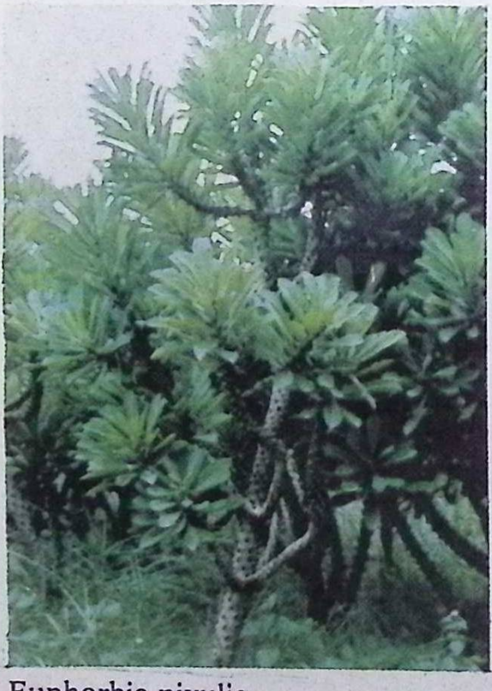
Ceiba pentandra



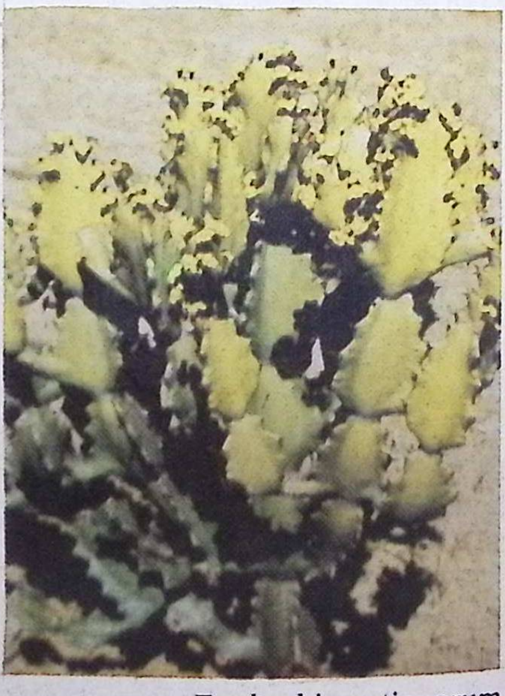
Shoots with red and white flowers



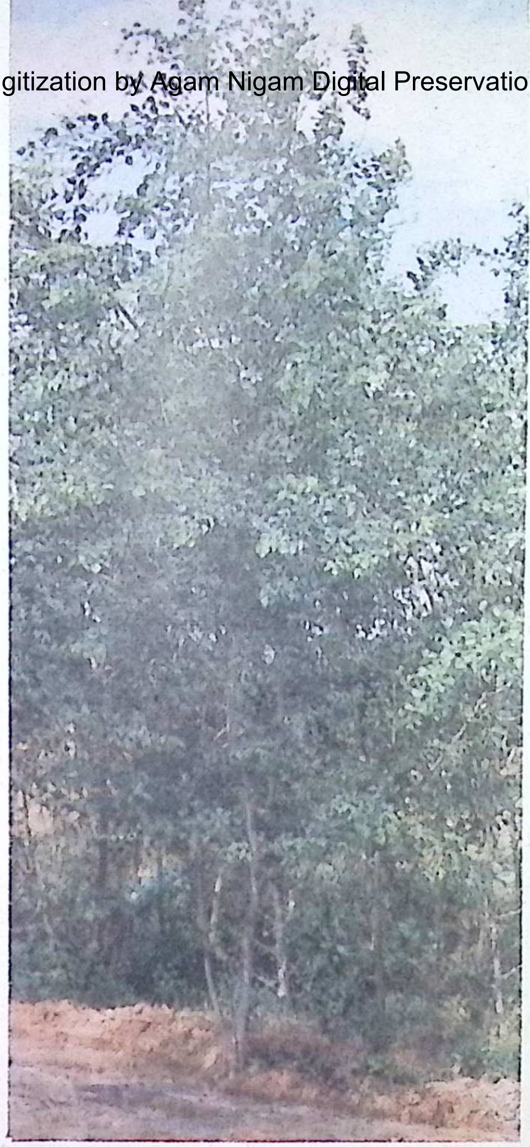
Erythrina indica



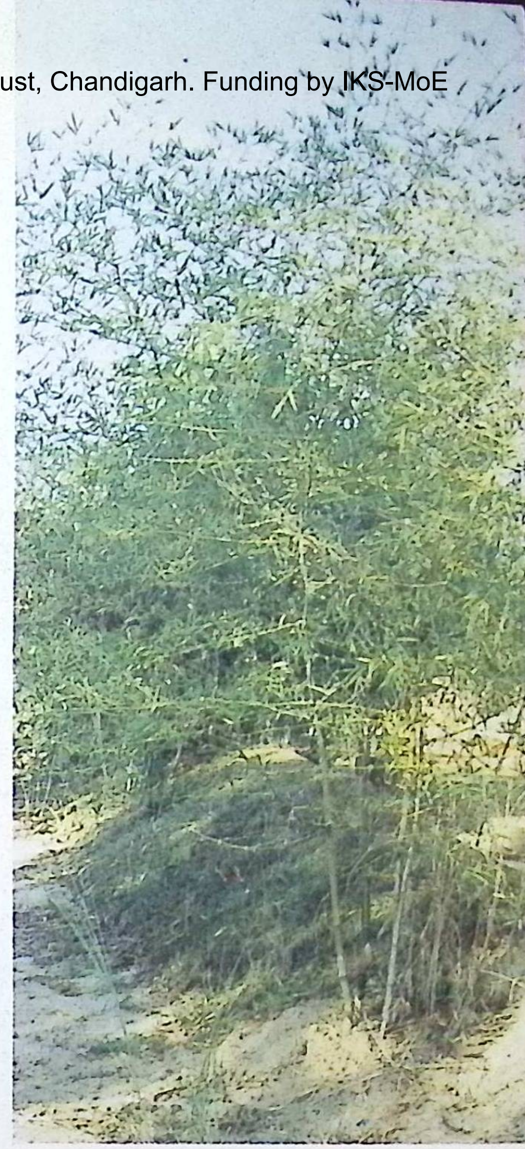
Euphorbia nivulia



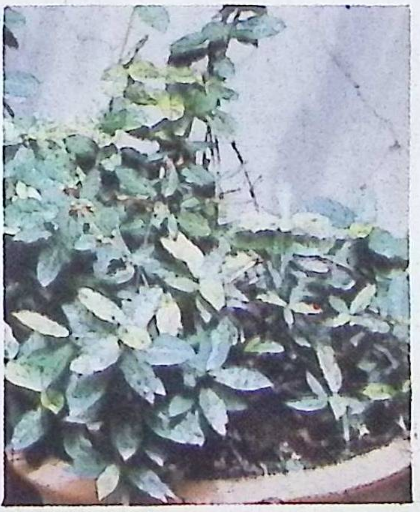
Euphorbia antiquorum



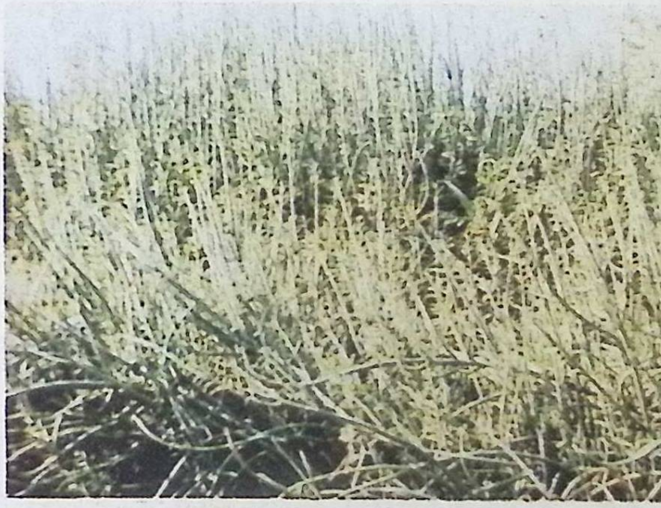
Dalbergia sissoo



Dendrocalamus strictus



Hemidesmus indicus



Euphorbia antisyphilitica

Eucalyptus Hybrid

Euphorbia trigona

Euphorbia royleana

direct sowing on well-worked soils in June in 30 cm lines; 3–4 seeds sown in each stake during rains; thinned or gap-filled to 1.8 m × 1.8 m in moist weather. Mixed with other species in South India. Can be transplanted with ease when 15–30 cm high. Stump-planting can be preferred when rainfall is sparse and irregular. A few diseases and pests have been recorded.

UTILIZATION

Reclamation—Promising for afforestation of wastelands in arid and other areas and where organic manure is deficient, and degraded soils, brackish-water soils, saline and alkaline, skeletal, shallow sandy loam, sandstone, rocky, refractory sites, denuded slopes, deep sandy soil, dry, semi-moist, waterlogged areas, gullies and ravines. One of the chief species for dry areas of Andhra Pradesh, Karnataka and Tamil Nadu for afforestation as it is not exacting for soil; extensively planted in forests. Recommended for social forestry, shelterbelts and windbreaks, hedges and roadsides to control sand-drifts; reported to fix nitrogen and supplies green manure, and can be made into compost.

Host for sandalwood (*Santalum album*); nurse-crop for *Swietenia mahogoni*; and controls *Lantana* spp and *Imperata cylindrica*. Host for lac-insect.

Timber—Helves; walking-sticks, cabinet-work, posts, props, inlayworks; and pulp; heartwood used for tanning and dyeing; causes irritation.

Fuel—Extensively planted for the excellent firewood; yields good charcoal.

Fodder—Leaf lopped for livestock.

Others—Bark: Yields tannins (22.84%) and can be substituted for wattle. *Leaf:* Contains tannins; purgative. *Root:* Anthelmintic; used for preventing convulsions in children. *Flower:* Eaten in curries. *Seed:* Endosperm yields mucilage (crude protein, 21.8%).

C. tora Linn.; Baker (Fl Br Ind) in part FOETID CASSIA, THE SICKLE-SENNA, WILD SENNA

Beng & Oriya–*Chakunda;* Guj–*Kawario;* Hindi–*Chakavat;* Kan–*Gandutogache;* Mal–*Chakramandrakam, takara;* Mar–*Takala;* Sans–*Chakramarda;* Tam–*Tagarai;* Tel–*Chinnakasinda.*

Jammu–*Haedma;* Madhya Pradesh–*Carota;* Punjab, Rajasthan & Tripura–*Chakunda.*

Habit—A foetid, annual herb or undershrub, up to 1.2 m. *Leaf*—6.0–12.5 cm long: leaflets 3 pairs, membranous, ovate-oblong with glands in the last 2 pairs, showing sleeping movements. *Flower*—bright yellow, usually in pairs in very short, axillary peduncles. *Fruit*—stout pod, 15–25 cm long. *Seed*—green, 25–30.

Distribution and Ecology—Throughout India, up to 1550 m, found as weed in semi-arid and humid regions, and polluted environment and as ground-cover in dry, deciduous forests.

UTILIZATION

Reclamation—Recommended for afforestation of saline, alkaline and brackish soils and semi-arid and humid areas; appears to prefer polluted environment. Serves as a green manure for acidic soils.

Fodder—Consumed by cattle when ensiled in pits before flowering; paddy- and wheatstraw can be added; feed for ostriches. Dried seed can be given as a protein-rich (crude protein, 23.77%) food for livestock and poultry.

Others—-Herb: Purgative, anthelmintic and antibacterial. Extracts show interferon-like activity; constituent of *Chakramadha tailamu* for eczema, ringworm and other skin-diseases. Substituted for soap. *Shoot & Leaf:* Tender shoots eaten as a vegetable (protein, 4.5%) and in soup. A tea is also made. *Leaf:* Purgative, anthelmintic, antiperiodic and extremely useful in ringworm and other skin-diseases, cuts and wounds and ulcers poulticed with it for early suppuration. Sometimes used to adulterate true senna. Decoction is given to children during teething. *Root:* Has many similar properties as those of shoots. *Fruit:* Unripe cooked and eaten. *Seed:* Eaten in times of scarcity; used in sweets; roasted seeds substituted for coffee. Tonic, stomachic; used in ringworm and other complaints of skin, liver, eye and ear; decoction considered blood-purifier. Yields tannins and yellow, blue and red dyes; used for tanning and dyeing. Yields a gum (7.65%); good agent for suspending and binding.

C. montana Heyne ex Roth (Guj–*Jhadoval;* Kan–*Bettadatangeedi;* Tel–*Kondatangeedu*) is a small tree, with yellowish pubescence, 10–20 cm long leaves, yellow flowers in corymbs, glossy-brown pods, found in Tamil Nadu, Karnataka, Andhra Pradesh, and some parts of Gujarat; cultivated in gardens. Useful for denuded soils; timber is used in household and as fuel. A host for *Santalum album.*

C. nigricans Vahl (Tam–*Suriyanvanangi, thozkukani)* is a shrub or undershrub, 1.5 m, with 5–10 cm leaves having linear-oblong leaflets, solitary or 2–5, yellowish-red flowers and linear-oblong pods with brown, shining seeds, found along the coastal regions of North Karnataka and in Tamil Nadu. Well-suited for growing on dry, gravelly areas; can also be used as green manure; leaves used as tea, and its powder added to food to improve appetite.

C. pumila Lamk.(Guj–*Chamedian;* Kan–*Nelatagache;* Mar–*Sarmal;* Tel–*Nallajeelugu;* Bihar–*Chotka aura;* Rajasthan–*Karolia*) is a prostrate, suberect or erect herb or undershrub, up to 1m, having 3–5 cm long leaves with 20–22 pairs of linear or oblong leaflets, yellow, solitary or 2–3 flowers in axils and linear, flat pods with 6–12, brown, obovoid-cuneate seeds, found almost throughout India, up to 2100 m. An excellent soil-binder, grown for conserving terraces and desert-soils; used as green manure for rubber, coconut and tea; suppresses weeds to some extent. Fixes nitrogen.

C. spectabilis DC. (ARCHIBALD'S CASSIA, CALCEOLARIA CASSIA) is a fast-growing, spreading tree, up to 20 m, having 25–40 cm long leaves with 5–18 pairs of glabrous leaflets, yellow flowers in terminal corymbs, cylindrical or somewhat quadrangular pods and slightly brown, more or less quadrate seeds, native to tropical America, introduced into India, occasionally planted in the gardens for ornament in some parts of Rajasthan and Karnataka. Successfully planted on lignite-mined areas in Tamil Nadu. Wood used for houseposts and poles in Africa; tree yields a dye and senna; the latter can be a cheaper substitute for true senna.

CASUARINA Rumph. ex Linn. (*Casuarinaceae*)

Tall, evergreen, xerophytic trees or shrubs, known as BEEFWOOD TREE; East Africa, South-East Asia to Australia, the Polynesia and the Mascarene Islands; 9 spp introduced into India for conservation of soil and fuel.

A few are hosts for *Santalum album.*

C. equisetifolia Linn. AUSTRALIAN OR WHISTLING PINE, CASUARINA

Beng–*Jau;* Guj & Hindi–*Jangli saru;* Kan–*Chabaku;* Mal–*Chavukku;* Mar–*Suru;* Tam–*Savukku;* Tel–*Saravi, sarugudu.*

Andamans–*Pinlebabwe.*

Habit—A quick-growing, evergreen tree, 40 m or more/1.8 m. *Stem*—straight, with slender branches. *Bark*—greyish or rusty-brown or maroon. *Leaf*—reduced to minute scales or spine-like as in *Pinus* or *Equisetum. Flower*—dioecious: male in slender, terminal spikes; female in ovoid or cone-like heads; February–April. *Fruit*—echinate, hard, 1–2 cm diam; June–December. *Seed*—light, membranous; 750,000–760,000/kg; germination 3–10 days extending up to 30 days, up to 80%; viability low; sometimes soaked in water for 24 hrs.

Distribution and Ecology—Native to Australia and adjoining Islands, introduced into India. Extensively cultivated as plantations on the coastal regions and hinterland and in the Andamans, with a rainfall of 870–2500 mm; also cultivated in Punjab, Haryana and Delhi. Characteristically a plant of

Casuarina equisetifolia

seashore from Gujarat to Orissa, and in some parts of West Bengal and the Andamans. Found in marshy places in open situation with sunshine where the *p*H varies between 4.0 and 8.0, waterlogged areas, coastal areas with salty vapours and beaches, flooded alluvial soils, poor soils, black cotton-soils and highly saline soils. Heavy and clayey soils with poor drainage are detrimental. Heavy rainfall and year-round humidity help the tree grow fast.

Silvicultural Characters—A light-demander. Drought-tolerant. Tends to become bushy when watertable is low and dies when raises to surface; lives for more than 50 years; under unfavourable conditions stem becomes hollow and contorted. Trees felled with a rotation of 7–35 years, 7–10 years being profitable.

CULTIVATION/REGENERATION

Natural Regeneration—Rare, except in Uttara Kannada.

Artificial Regeneration—Propagation through seed; fresh seed sown in well-prepared nurserybeds of 3.6 cm × 1.2 m and watered with fine hose and sprayed Gammexane or BHC and covered; 7–13 cm seedlings transplanted into polythene-bags during the rains; when 30–60 cm, transplanted at 1.8–3.6 m asunder. In Andhra Pradesh, it is directly sown; spacing depends upon utilization. Also, vegetatively propagated through air-layers and suckers. Several fungi and insects have been recorded.

UTILIZATION

Reclamation—Extensively cultivated on wastelands for reclamation, and for fuel; can be grown for erosion-control on all soils mentioned above; suitable for grassy blanks. Recommeded and also grown as evergreen shelterbelts, windbreaks, roadside trees and as sand-binders. Numerous stretches of land on the seacost, where other species cannot be introduced, are planted; recommended for agro- and social forestry. Produces greater biomass per unit area per unit time. Fixes nitrogen. Leaf made into compost and ashes used as manure.

Timber—Posts, poles, walking-sticks, gates; fences, toolhandles, paperpulp, hardboard and chipboard.

Fuel—Best firewood and burns even when green (4950 kcal/kg); extensively utilized for fuel and charcoal; ashes retain heat for a long time.

Others—*Bark:* Astringent; useful in ulcers, constipation, diarrhoea and dysentery; powder used for treating pimples; decoction emmenagogue. Yields tannins (6–18%) and resin; used for tanning leather and dyeing fishing-nets, woollens and silks. *Leaf:* Powdered and boiled in oil, used in diseases of ear. Extract shows anticancer activity. Used for preparing activated carbon. *Seed:* Powdered and applied as a plaster in headache.

C. junghuhniana Miq. syn. *C. montana* Jungh. ex Miq.

Habit—A large, quick-growing, pyramidal tree, with hair-like, ultimate branches. *Leaf*—scale-like, in whorls. *Flower*—dioecious: male spikes ellipsoidal or cuneate. *Seed*—130,000–150,000/kg; January, May and September.

Distribution and Ecology—Introduced into Tamil Nadu and Punjab; cultivated on sand-dunes, chiefly in Orissa; probably grows in temperate regions also. Grows on sand-dunes, arid and semi-arid regions.

Silvicultural Characters—Drought-resistant. Windfirm.

Cultivation/Regeneration—Originally introduced stock is male; hence, propagated from half-ripe shoots and rootsuckers and airlayers.

UTILIZATION

Reclamation—Suitable for reclamation of coastal sand-dunes and arid and semi-arid regions; already grown for erosion-control. Fixes nitrogen.

Timber—Paperpulp.

Fuel—Used as firewood.

C. cristata Miq. and *C. cunninghamiana* Miq. are large trees, 15–20 m, introduced from Australia, found suitable for cultivation in arid and semi-arid areas and on sand-dunes and saline soils and as shelterbelts. Timber of the latter useful for wagons, shingles, staves and for turnery; bark yields tannins (7–11%). *C. glauca* Sieb. ex Spreng. and *C. obesa* Miq. are large shrubs or small halophytic trees, 8–10 m, introduced from Australia, useful for cultivation on wastelands, and as shelterbelts; suitable to check wind-erosion; bark of *C. glauca* yields tannins (10.19%). *C. paludosa* Sieb. ex Spreng. syn *C. distyla* Vent. var. *paludosa* Benth., *C. stricta* Ait., non Miq. syn. *C. quadrivalvis* Labill., *C. littoralis* Salisb. syn. *C. suberosa* Otto & Dietr. and *C. leptoclada* Miq have also been introduced into India for cultivation on the Nilgiris.

CATHARANTHUS G. Don (*Apocynaceae*)

Perennial herbs; tropics, especially in Malagasy; 2 spp in India.

C. roseus G. Don syn. *Vinca rosea* Linn.; *Vinca pusilla* Hook. f. (Fl Br Ind) in part, non Murr.; *Lochnera rosea* (Linn.) Reichb. MADAGASCAR OR RED PERIWINKLE

Beng–*Gulferinghi;* Guj–*Barmasi;* Hindi–*Sadabahar;* Kan–*Kempukasikanegalu;* Mal–*Ushamalari;* Mar–*Sadaphul;* Oriya–*Aniskati;* Tam–*Sudukadu mallikai;* Tel–*Billaganneru.*

Punjab–*Rattanjot.*

Habit—An erect, slightly smelling, perennial herb, 30–90 cm. *Leaf*—oval, obovate or oblong-elliptic, acute, glossy. *Flower*—usually 2–3, fragrant, pinkish (var. *roseus*) or white (var. *alba*) throughout or pink or yellowish in the orifice (var. *ocellatus*), in terminal or axillary cymose clusters. *Fruit*—hairy, many-seeded follicles, 2–3 cm long. *Seed*—oblong, minute, black; germination 10 days.

Distribution and Ecology—Native to Malagasy, naturalized throughout India, up to 1300 m, particularly wild in some regions as in Andhra Pradesh, especially in coastal areas; also cultivated for ornament. Now cultivated on large scale in Tamil Nadu, West Bengal and Karnataka for medicinal alkaloids; also recommended for plantation scale in Assam and Andhra Pradesh. Very hardy; luxuriantly grows on a variety of soils and in climates, except highly alkaline or waterlogged soils. Found as an escape in waste places and sandy tracts.

Cultivation/Regeneration—Needs a well-distributed rainfall of 100 cm with mild tropical climate for a rainfed crop. Soil brought to a fine tilth;

Catharanthus roseus

manured with 10–25-tonne FYM or compost/ha added with 2,4-D and Gammexane. Propagated from seed or stem-cuttings. Fresh seed directly sown (2.5 kg/ha) in the field during rains in late June at 10–15 cm; for transplanting, 1kg seed is needed for a hectare and irrigated; after 30–45 days and at the stage of a pair of leaves transplanted at 30 cm × 45 cm, with 7000 plants/ha. Responds well to manures and fertilizers and micronutrients. Light irrigation needed when rains are inadequate; irrigation induces more biomass of leaves and roots; intercultured 2–3 times; mulching also helps; tops are cut for more vegetative growth. Leaves can be harvested twice and finally along with roots too and processed; yield of biomass varies (1.0–2.2 t/ha) from rainfed crop to irrigated crop.

UTILIZATION

Reclamation—A very hardy, drought-resistant plant which can be grown for controlling erosion on various soils, except waterlogged and highly alkaline soils. Recommended for social forestry.

Others—All parts possess several alkaloids. Some have shown hypotensive, sedative, hypoglycaemic activity. A few alkaloids are important in the treatment of various types of cancer, particularly leukaemia; possess antibacterial and antifungal activity. *Leaf:* Infusion in menorrhagia; juice for wasp-stings. *Root:* Toxic, stomachic.

CENCHRUS Linn. (*Poaceae*)

Annual or perennial grasses; tropical and sub-tropical world; 8 spp in India.

C. biflorus Roxb.; Hook. f. (Fl Br Ind) in part syn. *C. catharticus* Delile; Hook. f. (Fl Br Ind) in part; *C. barbatus* Schu. GRAMAGRASS, BLUEPANIC

Delhi–*Bhurat;* Rajasthan–*Bhront, kali anjan dhaman.*

Habit—A fast-growing, erect or geniculately ascending, simple or branching perennial, 15–60 cm. *Culm*—40 cm tall, arising from rhizome. *Leaf*—lanceolate, rough, dark bluish-green, ciliate or glabrate, 2.5–15.0 cm × 0.5 cm. *Inflorescence*—lax raceme. *Spikelet*—2–1-flowered. *Fruit*—ovoid-oblong, pale, smooth, shining caryopsis. *Flowering & Fruiting*—July–October.

Distribution and Ecology—Commonly found in the arid regions in Haryana, Delhi, Uttar Pradesh, Rajasthan, Gujarat, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu on sandy or dry, arid and semi-arid soils with 400–500 mm rainfall; also found on wastelands and fallow-fields, shallow waters, canalbanks and in lawns. Drought- and frost-resistant.

Cultivation/Regeneration—Seed or rooted slips planted during rains, seed being the easiest. Seed (5 kg/ha) is sown at 5–100 cm and later thinned or gap-filled; interculturing essential; fertilizers improve the crop. Since growth is fast, harvest before flowering and subsequent growth should be utilized for grazing.

UTILIZATION

Reclamation—Can be planted for afforestation and to prevent erosion of wastelands, fallow-fields, shallow-water areas, canalbanks, calcium-deficient soils along with other plants and on saline soils, and mineral soils. Capable of absorbing high amounts of sodium. Recommended to grow as shelterbelts and windbreaks for controlling sand-drift areas; also suited for rangelands.

Fodder—One of the best for grazing and hay-making;and highly nutritious (crude protein, 21.18%); stimulates production of milk.

Others—*Seed:* Mixed with *bajra* and eaten by humans; bread is considered nutritious during famine; in normal times, mixed with sugar and *ghee* and given for health; decoction pectoral and diuretic.

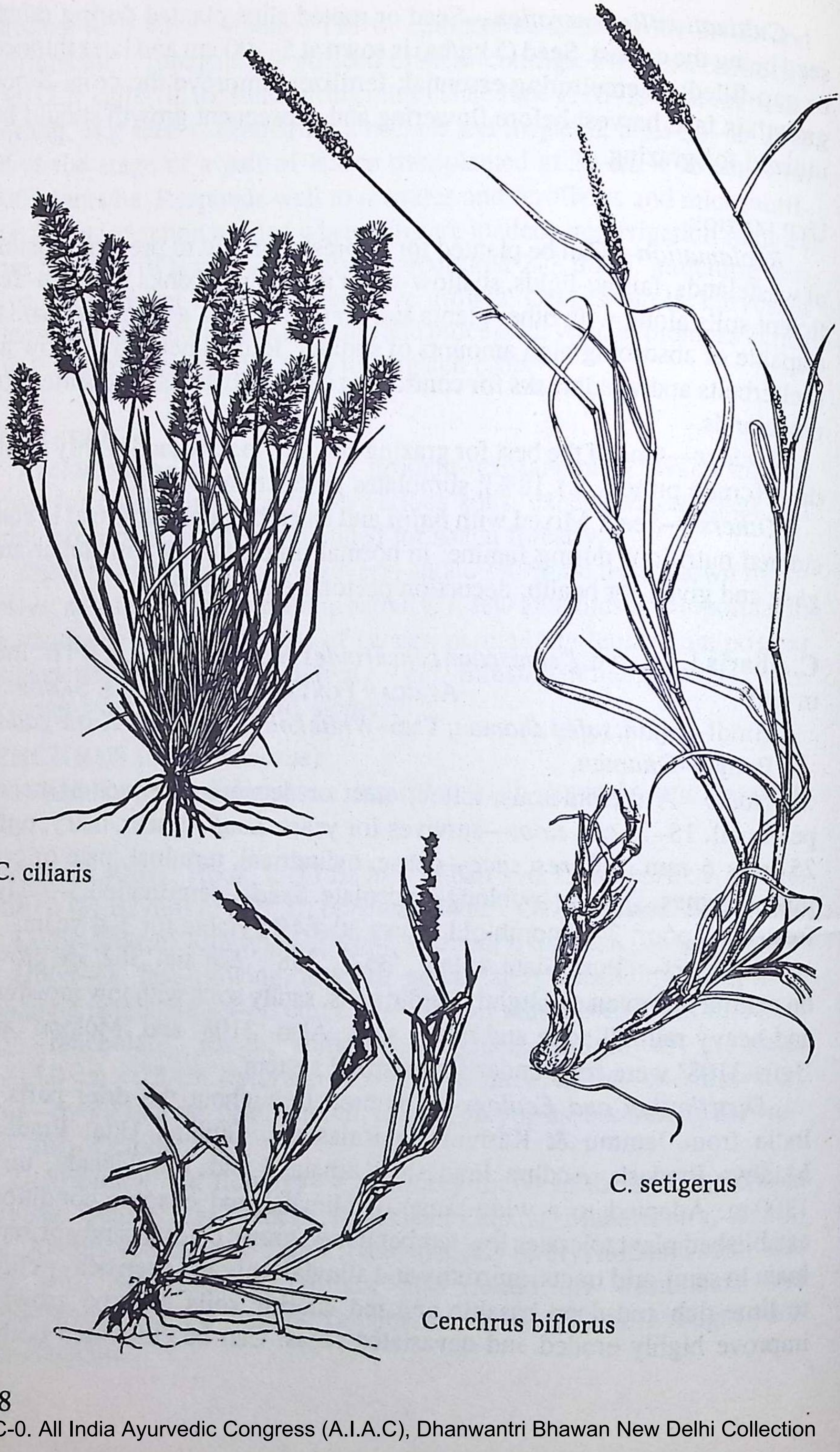
C. ciliaris Linn. syn. *Pennisetum cenchroides* A. Rich.; Hook. f. (Fl Br Ind) in part AFRICAN FOXTAIL, BUFFELGRASS, SANDBUR

Hindi–*Anjan, safed dhaman;* Tam–*White kollukattai;* Tel–*Kusa-gaddi.* Punjab–*Dhaman.*

Habit—A rhizomatous, tufted, erect or decumbent, much-branched perennial, 15–75 cm. *Root*—survives for years. *Leaf*—linear, hairy, up to 25 cm × 6 mm. *Inflorescence*—dense, cylindrical, terminal, pale or purplish racemes. *Spikelet*—oblong-lanceolate. *Seed*—germination 3–7 days, fresh ones poor; 3–4-month-old shows 30–64%; viable for 3–4 years.

Cultivars—'Pusa Giant Anjan', '357', '358', '226' and '362' are grown on neutral and even on slightly acidic soils, sandy soils with low moisture, and heavy rainfall zone and heavy soils. Also '3108' and 'Molopo' and 'Igfri-3108' were tried under silvipastoral system.

Distribution and Ecology—Common throughout the drier parts of India from Jammu & Kashmir to Rajasthan, Gujarat, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Karnataka and Tamil Nadu, up to 1200 m. Adapted to a wide range of climatic and edaphic conditions; established plant tolerates low temperatures; grows on dry, sandy or sandy loam in semi-arid tracts, murrumy and alluvial soils and even heavy clayey to lime-rich and deep basaltic and red lateritic soils. Can be grown to improve highly eroded and devastated areas. Can be cultivated both in



C. ciliaris

C. setigerus

Cenchrus biflorus

extremely arid conditions and in areas with 150–1250 mm rainfall. Drought-resistant and hardy.

Cultivation/Regeneration—Though can be grown on many types of soils, prefers liberal moisture and well-drained soils. Soil worked to a fine tilth with manure and fertilizers which increase protein and phosphoric acid. Easily propagated from seed (4.5–11.0 kg/ha), nursery-raised seedlings (5 kg/ha) or rooted slips; seed mixed with sand and broadcast or made into pellets and planted during monsoon or under irrigation in arid and semi-arid and in humid areas; establishes in 60 days; reseeding may be necessary in arid and semi-arid areas; 21-day-old, 20–22-cm-high seedling can be transplanted, 30–60 cm apart on ridges after monsoon; rooted slips are also horizontally planted; 1–2 weedings essential. Mixtures with *Lasiurus sindicus* on light soils of arid tracts, *Cenchrus* spp and *Dichanthium* spp on heavy soils and legumes, such as *Cyamopsis tetragonoloba, Vigna aconitifolia*, *V. radiata* and *V. unguiculata* increase yields by 20–30%. Harvesting or grazing in the first year should not be permitted. Pastures are opened after third year and maintained for 5–40 years. Yield of green fodder is high even in arid tract.

UTILIZATION

Reclamation—Can be grown on various types of soils with its hardy rootsystem for controlling erosion; can be grown on soils mentioned above; also can be grown to develop the highly eroded or devastated areas, coastal saline soils, sand-dunes, gullies and ravines, grasslands and rangelands but not suitable for highly saline and waterlogged areas. Several cultivars for various types of soils have been developed. Some are reported to grow on neutral and even on slightly acidic soils, semi-arid sandy soils in Rajasthan and a few in heavy rainfall zone and heavy soils. Two cultivars have been tried under silvipastoral system. Recommended for social forestry.

Fodder—Highly valued as green fodder and animals readily eat. Forms a dominant grass in pastures; also cultivated for fodder in Tamil Nadu. Highly palatable and nutritive at all stages (crude protein, 13.82–16.9%); enhanced by fertilizers. Can be converted into hay (crude protein, 9.74%) and silage. Yield of milk increases. Provides a sleek, glossy coat.

Others—Seed: Used for adulterating human food.

C. glaucus Mudaliar & Sundararaj BLUO BUFFELGRASS

Habit—A tall, perennial grass. *Rhizome*—deep-rooted. *Culm*—stiff, tall. *Leaf*—linear, bluish-green, rough-glaucous. *Inflorescence*—compact, long, with spiciform spikes. *Fruit*—oblong caryopsis.

Distribution and Ecology—Tamil Nadu; being popularized for cultivation in Tamil Nadu. Well-adapted for a wide range of soils and cultivated as rainfed and irrigated crop. Drought-resistant and suitable for dry conditions.

Cultivation/Regeneration—Easily establishes from seed or rooted slips forming large tussocks.

UTILIZATION

Reclamation—A good soil-binder and ideal for conservation of soil. Well-suited for several types of soils.

Fodder—Palatable and nutritious (crude protein, 10.63%) and superior to many other grasses. Yields green fodder even during summer.

C. setigerus Vahl syn. *C. biflorus* Hook. f. (Fl Br Ind) in part, non Roxb.

BIRDWOOD-GRASS

Hindi–*Dhaman;* Tam–*Karuppu kolukattai, black kolukattai.*
Rajasthan–*Motadhaman, kaladhaman.*

Habit—A tufted annual or perennial. *Stem*—glabrous, erect or ascending from bulbous base. *Leaf*—linear-lanceolate, glabrous 8–20 cm × 0.3–0.7 cm. *Inflorescence*—compact, racemose, green at first, turning white, purple and finally black, with 2–3-flowered spikes having spines. *Fruit*—ovoid or broadly oblong, smooth, shining caryopsis, 2 mm long. *Seed*—September–October in arid tract and under irrigation; no dormancy; germination 15 days in dry tracts and quicker in irrigated areas; retains viability for 4–5 years when stored.

Cultivars—(*i*) '175'–suitable for sandy soils with low moisture; yields high; foliage broad, dark green; (*ii*) 'Pusa Yellow Anjan'–persistant, aggressive; yields soft, succulent leaves; quickly recovers from grazing; and (*iii*) 'P.S.31'–yields high; superior quality.

Distribution and Ecology—Common weed from Jammu to Uttar Pradesh, in Madhya Pradesh, Rajasthan, Gujarat, Maharashtra and Tamil Nadu and probably in southern Andhra Pradesh. Adapted for a wide range of climate and soil but suited for high altitudes. Grows in extremely arid and humid conditions with 125–1250 mm rainfall. Found in dry, sandy, sandy loam, gravelly, alluvial and murrumy soils and used for lawns. Also grows on deep, basaltic, red-laterite and calcium soils. Not suitable for saline and waterlogged conditions. Drought-resistant.

Cultivation/Regeneration—Soils thoroughly worked along with farmyard manure into a fine tilth; seed at the rate of 4 kg/ha for dry land, 2 kg/

ha for humid and irrigated areas is sown or rooted slips can be employed. Planted in rainy season in rows at 75 cm spacing for arid tracts, and 25–50 cm for humid or irrigated tracts at a depth of 5–6 cm or broadcast and covered by a layer of soil; 1–2 weedings in the first year and interculturing in subsequent years needed. Fertilizers and bonemeal stimulate growth, increase yield of fodder, and increase crude protein. May be intoduced in ley-farming with *bajra*; may also be mixed with *Lasiurus sindicus*, *C.ciliaris* and *Panicum antidotale;* with *Atylosia scarabaeoides* and *Dolichos lablab* var.*lignosus* under arid conditions. Protection from grazing and cutting in the first year in arid tracts permits establishing; harvesting in irrigated areas can be once in 4–5 weeks in the first year during August–October; later cuttings depend upon growth.

UTILIZATION

Reclamation—Can be grown on depleted and devastated soils for rapid conservation and on soils as mentioned above; also on grasslands and rangelands, sandstone rocky sites, shifting sand-dunes and mineral soils.

Fodder—Leaf: Palatable at all stages (crude protein, 6%) and can be converted into hay. *Seed:* Ground and used as feed. Yield of milk increases and coat becomes glossy and sleek.

C. echinatus Linn. syn. *C. biflorus* Hook. f. (Fl Br Ind) in part, non Roxb., *C. quinquevalvis* Buch.-Ham. ex Wall.; *C. pennisetiformis* Hochst. & Steud. ex Steud. syn. *P.cenchroides* Hook. f. (Fl Br Ind) in part; *C. cenchroides* A. Rich. var. *echinoides* Hook. f. (Fl Br Ind) in part; and *C. prieurii* Maire syn. *P. prieurii* Kunth (Rajasthan–*Lambiobhurat*) are other species of arid areas of Rajasthan, Haryana and Punjab, utilized as fodder.

CERIOPS Arn. (*Rhizophoraceae*)

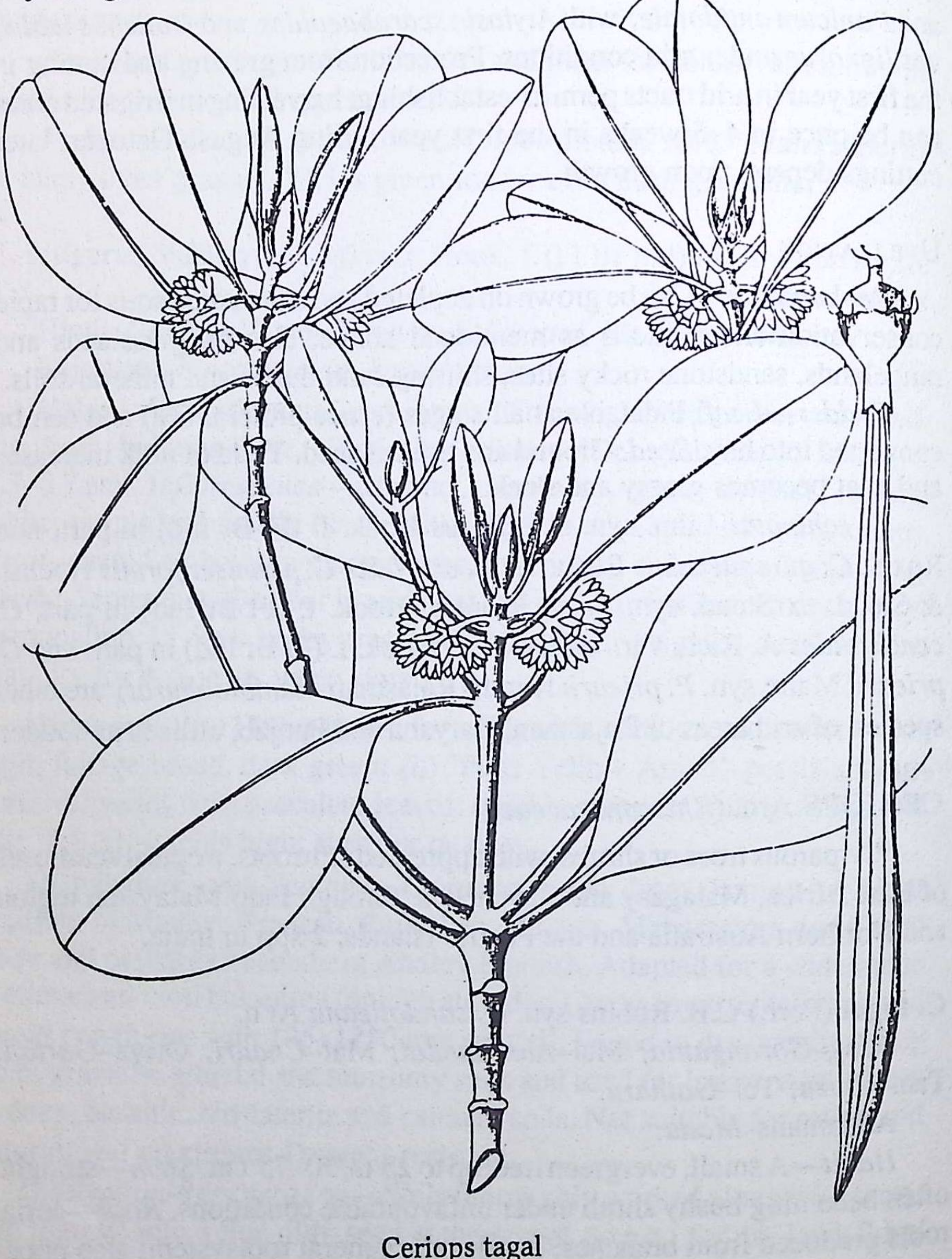
Viviparous trees or shrubs, with appressed stiltroots; tropical seashores of East Africa, Malagasy and Seychelles through Indo-Malaysian region and Northern Australia and the Pacific Islands; 2 spp in India.

C. tagal (Perr.) C.B. Robins syn. *C. candolleana* Arn.

Beng–*Goranguttia;* Mal–*Ann kandal;* Mar–*Chauri;* Oriya–*Gartah;* Tam–*Chiru;* Tel–*Gatharu.*

Andamans–*Mada.*

Habit—A small, evergreen tree, up to 25 m/50–75 cm. *Stem*—straight, often becoming bushy shrub under unfavourable conditions. *Root*—aerial roots produced from branches, besides the general rootsystem; also pneumatophores present. *Bark*—whitish, rarely smooth. *Leaf*—pale green, obovate to obovate-oblong, rarely elliptic-oblong, glabrous, thick, 3–6 cm × 5–10 cm. *Flower*—small, white or pale green, in clusters of 2–10, on the apex-nodes of new stocks. *Fruit*—dark brown, 1.5–2.5 cm long, club-shaped, with longitudinally grooved and ribbed radicle, exhibiting vivipary, 15–25 cm; ripen during August–September; 260–330 embryos/ kg.



Ceriops tagal

Distribution and Ecology—Coastal forests and estuarine regions of the peninsular India, in the Sundarbans of West Bengal and the Andaman and Nicobar Islands.

Cultivation/Regeneration—Radicle develops on the fruit before dropping on to the ground or into water; if touches the ground, establishes; otherwise continues to float till it anchors.

UTILIZATION

Reclamation—Recommended for cultivating on estuarine coastal wastelands to prevent erosion.

Timber—House- and boat-building, pitprops; and paperpulp.

Fuel—Commonly used as fuel (5150 kcal/kg). Yields excellent charcoal.

Others—Various parts of the plant yield tannins. *Bark:* May be more useful as a dye with indigo to obtain shades of brown, black or purple. Tan-extracts also used for softening water, in drilling-muds, ink-making, preservatives, plastics, resins and glue for plywood. *Fruit:* Boiled and eaten.

C. decandra (Griff.) Ding Hou syn. *C. roxburghiana* Arn.

Beng–*Bara goran;* Hindi–*Goran;* Oriya–*Gartah;* Tam–*Chiru;* Tel–*Gatharu.*

Habit—A shrub or small tree, 3–6 m, sometimes up to 15 m/0.75–1.3 m. *Leaf*—coriaceous, obovate or elliptic-oblong, 2.5–6.0 cm × 4.5–10.0 cm. *Flower*—greenish-white, 3–5, with prominent calyx-lobes, in axillary condensed head-like forms. *Fruit*—ovoid, conical, 1.0–1.75 cm long.

Distribution and Ecology—Mangrove-swamps of the West Bengal, Orissa, Andhra Pradesh and in Tamil Nadu along the eastern coast. Constitutes almost more than half of the total mangroves.

UTILIZATION

Reclamation—Recommended for cultivating in estuarine wastelands to prevent erosion.

Timber—Employed as poles.

Fuel—Used as fuel (5347 kcal/kg).

Others—*Bark & Leaf:* Important tan-stuffs (bark, 25.40%), used for tanning fish-nets. *Stem:* Yields tannins (7–10%).

CHLORIS Sw. (*Poaceae*)

Annual or perennial grasses, known as FINGER- OR WINDMILL-GRASS; in warm-temperate and tropical regions; 10 spp in India.

Many species are useful fodders: some ornamental and others good soil-binders and can be planted for reclaiming the soils and controlling erosion.

C. barbata Sw. syn. *C. inflata* Link

Hindi–*Jargi;* Kan–*Manchadakaalaehullu;* Tam–*Kuruttupul;* Tel–*Uppugaddi.*

Habit—A perennial, geniculately ascending, branching upwards. *Stem*—tufted, with strong root-fibres, rather stout, 60–90 cm, leafy, smooth. *Leaf*—narrowly linear, flat or folded, 15–25 cm. *Inflorescence*—spikes 5–20, digitately arranged, often purplish. *Spikelet*—green or purple, 2 mm excluding awn, 3-awned.

Distribution and Ecology—Throughout the plains of India on almost all soils, becoming an obnoxious weed in dry fields.

UTILIZATION

Reclamation—Singly or in mixture with *C. virgata* helps in reclamation of saline and alkaline, and sandy soils.

Fodder—Good before flowering; hay palatable and nutritious (crude protein, 6%).

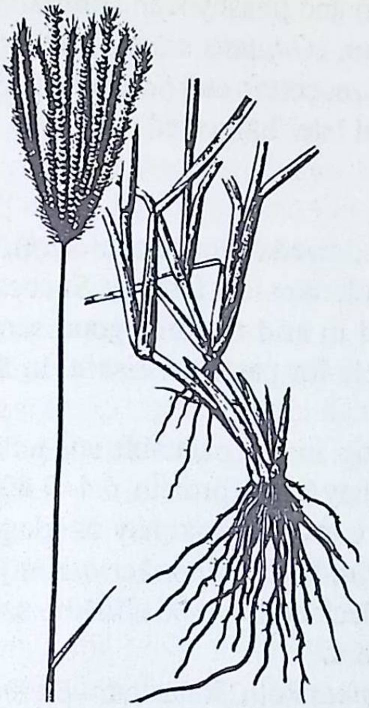
C. gayana Kunth GIANT RHODES, RHODES-GRASS

Kan–*Rhoodsoohullu.*

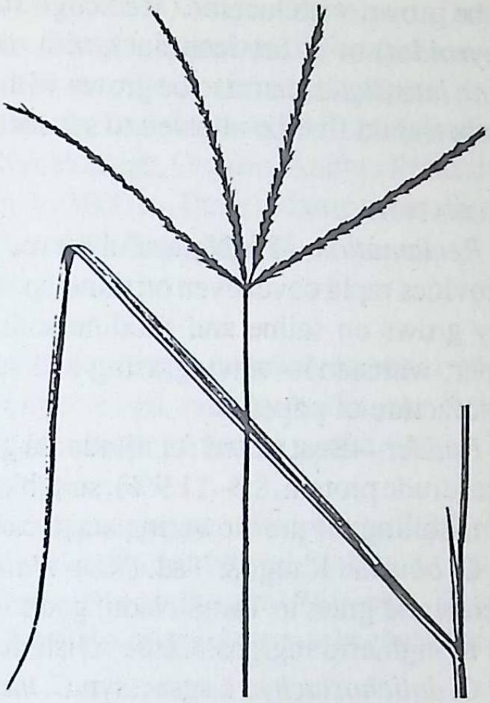
Habit—An annual or perennial, vigorous-growing grass. *Stem*—1.0–1.5 m, with long, stout stolons, compressed, tough and wiry internodes. *Leaf*—3–5 mm wide, tapering to a fine point. *Inflorescence*—spikes many, erect or ascending. *Spikelet*—crowded, pale tawny. *Seed*—small, difficult to collect; 1650–4400/kg; October–November; germination 7–10 days, decreases with storage.

Distribution and Ecology—Introduced into India from South Africa, cultivated for fodder in many parts of India in tropical and subtropical, low-lying areas. Best suited to areas with a rainfall of 750–1250 mm; can tolerate drought and moderate frost. Luxuriant on moist, loam soils with drainage but does not tolerate stiff clay or waterlogging; grows on saline and alkaline soils.

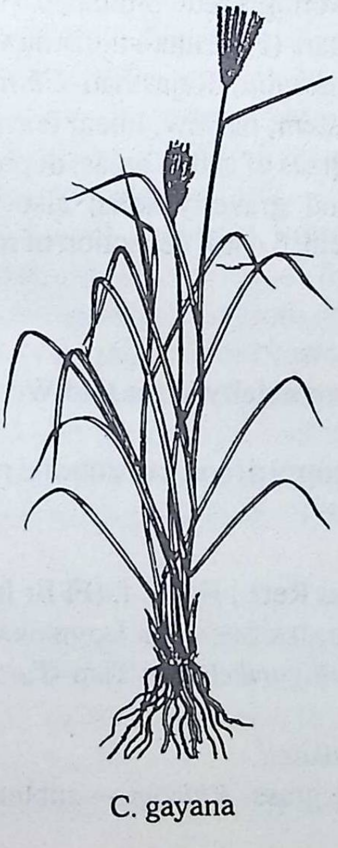
Cultivation/Regeneration—Can be established from seed or rooted cuttings; land worked to a fine tilth, seed (rainfed: 4.5–8.0 kg/ha; heavy rainfall or irrigation: 11–13 kg/ha) broadcast in first rains, preferably mixed with sand. Rooted cuttings (24,700/ha) transplant well at 45 cm spacing; may be planted at any time; interculturing once or twice and irrigation at 2–3-week interval or as needed be given; manures and fertilizers encourage growth; ready for cutting in 90 days from seed and 60 from rooted cuttings; harvested before flowering; 7–12 cuttings can be obtained depending upon climate. Can also be irrigated with water or stable-washings. Can profita-



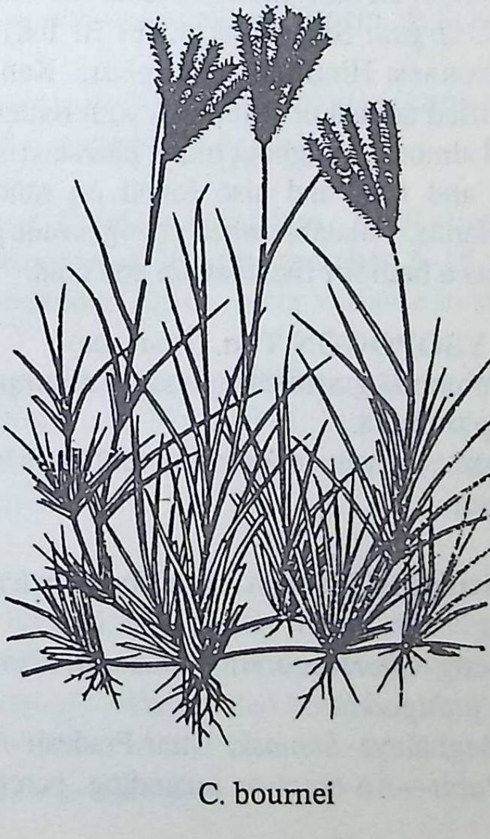
Chloris barbata



C. dolichostachya



C. gayana



C. bournei

bly be grown with lucerne (*Medicago sativa*) and phaseybean (*Phaseolus lathyroides*) or in between lines with redgram (*Cajanus cajan*) and *Leucaena latisiliqua*; can also be grown with maize, cotton and *Sorghum*. New stands should first be allowed to set seed and later harvested.

UTILIZATION

Reclamation—Highly useful for reclamation and to control erosion, as it provides rapid cover even on mine-spoils; tolerates low fertility. Successfully grows on saline and alkaline soils and in arid regions; good sand-binder; withstands heavy grazing and suitable for pastures. Useful in the manufacture of paper.

Fodder—Best suited for rotational grazing. Leafy, palatable and nutritious (crude protein, 8.5–11.9%); suitable for hay (crude protein, 6.4–9.4%), or for soiling; in pre-flowering stage can be converted into hay or silage.

C. bournei Rang. & Tad. (Kan–*Halahullu;* Tam–*Periyakuruttupul*) is an endemic grass to Tamil Nadu; good for black cotton- and alkaline soils and in high,arid regions. Cattle relish the grass.

C. dolichostachya Lagsac. syn. *C. incompleta* Roth.(Rajasthan–*Bamna;* Uttar Pradesh–*Bansi*) is a straight-stemmed grass, common on all types of soils; one of the best grasses for fodder before flowering (crude protein, 6.7%).

C. virgata Sw.; Hook. f. (Fl Br Ind) in part (FEATHER-FINGERGRASS, SWEETGRASS; Hindi–*Gharaniaghas;* Kan–*Gudihullu;* Rajasthan–*Chinki*) is a tufted annual or perennial, with flattened stem, narrow, linear leaves, found almost throughout India; characteristic grass of saline areas, depressions and flats and also found on sandy and gravelly soils; also on rangelands. Palatable when young (crude protein, 6.4%); decoction of root used as a bath for rheumatism and cold.

CHRYSOPOGON Trin. (*Poaceae*)

Perennial grasses; tropics and subtropics, especially in the Old World; 14 spp in India.

Some are valued for fodder and some for control of soil-erosion and reclamation.

C. aciculatus Trin. syn. *Andropogon aciculatus* Retz.; Hook. f. (Fl Br Ind) in part LESSER SPEAR OR LOVE-GRASS

Beng–*Chorkanta;* Hindi–*Lampa;* Kan–*Ganjigarikehullu;* Tam–*Tuttiri;* Tel–*Putthigaddi.*

Meghalaya–*Samask;* Uttar Pradesh–*Kawakheti.*

Habit—An erect or ascending, perennial grass. *Rhizome*—subterranean, creeping, woody. *Culm*—20–60 cm. *Leaf*—densely tufted, 15 cm × 6 mm, flat, glaucous, glabrous, margins spinulose. *Inflorescence*—erect, pale or purplish panicles, up to 15 cm. *Seed*—linear caryopsis.

Distribution and Ecology—Commonly found as a weed from Kumaun to Tripura and Manipur, Orissa, Madhya Pradesh, Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Kerala, up to 2000 m. Prefers damp areas. Successfully withstands grazing and fire; resists drought well.

UTILIZATION

Reclamation—Plays an important role in conservation of water and soil, especially on dry, open fields along streams, railway-banks, etc. Recommended for conservation. Forms an excellent turf in moist places if mowed.

Fodder—Relished by cattle before flowering (crude protein, 2.7%).

Others—*Culm:* Woven into cigarette-cases; employed for brush-, hat- and mat-making. Decoction of the grass given as diuretic. *Rhizome:* Used for scrubbing. *Root:* Decoction used for diarrhoea and stomachache; ashes swallowed for rheumatism.

***C. fulvus** (Spreng.) Chiov. syn. *C. montanus* Trin. ex Spreng.; *Andropogon montanus* Koen. ex Trin.; *A. monticola*, Schult. ex. Roem. & Schult. var. *monticola*.

Hindi–*Chickua;* Guj–*Dongrigavat;* Kan–*Ganjigrikahullu;* Tam–*Cholappulu;* Tel–*Bograygaddi, gogadagaddi.*

Bombay–*Agiva*; Delhi–*Dhawalu.*

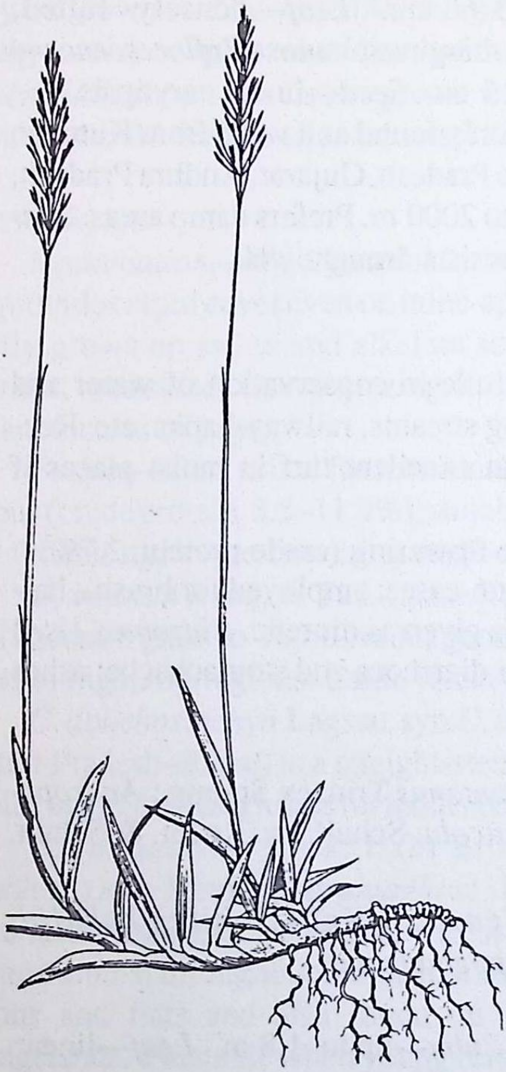
Habit—A perennial, tufted grass. *Culm*—up to 1.8 m. *Leaf*—linear, glabrous, up to 45 cm × 3 mm. *Inflorescence*—yellowish or purplish, 5–15 cm, branches in whorls, smooth or scaberulous. *Spike*—very variable in size, green, blue, purplish or brown.

Distribution and Ecology—South India, up to 1800 m; also in West Bengal and Meghalaya; probably North and North-West India. Found in open, dry and stony regions, especially on lateritic soils but remains stunted on these soils; grows tall on rich soils.

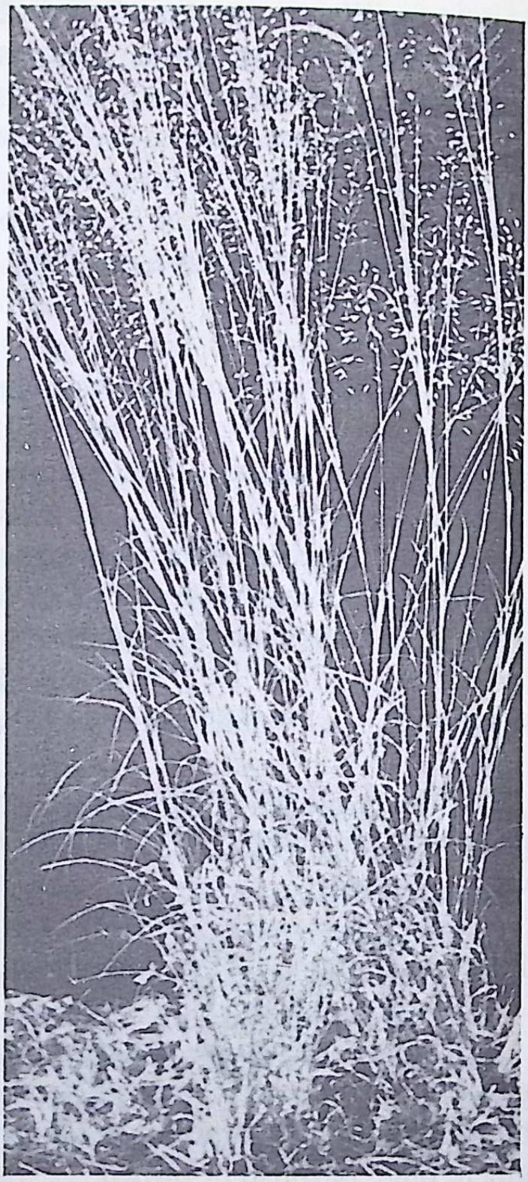
UTILIZATION

Reclamation—Can be grown for reclaiming soils mentioned above; also recommended for stabilizing the stream-banks and to prevent water-erosion; tufts used to prevent erosion of newly erected bunds.

**C. fulvus* and *C. serrulatus* appear to have been confused.



Chrysopogon aciculatus



C. fulvus

Fodder—Highly valuable and nutritious (crude protein, 6.14%) before flowering; can be converted into hay.

Others—Grass: Can form a constituent for pulp with other grasses.

C. serrulatus Trin. syn. *C. montanus* Trin. ex Spreng. var. *serrulatus* Stapf; *C. fulvus* (Spreng.) Chiov. var. *serrulatus* (Trin.) Stewart; *C. coerulus* (Nees ex Steud.) Wats.; *Andropogon monticola* Schult. ex Roem. & Schult. var. *trinii* Hook. f.

Hindi–*Goria.*

Jammu & Kashmir–*Dhaulu;* Madhya Pradesh—*Dhallu, jhingra-ka-jhara;* Punjab–*Dhaulian;* Rajasthan–*Karmi.*

Habit—A coarse, sparingly branched, perennial grass, leafy towards base. *Culm*—up to 2.5 m, tufted, terete. *Leaf*—flat, linear, with compressed sheaths. *Inflorescence*—oblong-ovate to pyramidal, yellowish, 3–12 cm.

Distribution and Ecology—Kashmir to Bihar, in Madhya Pradesh, Rajasthan, Gujarat, Maharashtra and Karnataka, up to 2100 m; in Ambala and Siwalik hills, a dominant species with *Acacia catechu* and *Eucalyptus* hybrid and on open grasslands with maximum yield from *Acacia* association. Thrives on shallow, stony or sandy soil with little or no water-holding capacity. Highly drought-resistant.

Cultivation/Regeneration—Propagated from seeds or slips. Well-established pastures can be raised in 3 years.

UTILIZATION

Reclamation—Can be grown to recloth the areas mentioned above.

Fodder—Valuable fodder before flowering (crude protein, 8.52%); can withstand repeated grazing and cutting after first year.

C. gryllus Trin. ssp. *gryllus* syn. *Andropogon gryllus* Linn.; Hook. f. (Fl Br Ind) in part (Jammu & Kashmir, Uttar Pradesh–*Kus, salum*) is a perennial, tufted grass, up to 1.8 m, with terete or compressed culms, linear leaves, found from Kashmir to Sikkim, in Meghalaya, Assam, Naga Hills, usually in dry areas, up to 2800 m; and also in Maharashtra, Karnataka and on the Nilgiris in Tamil Nadu; prefers stony and inhospitable soil, liable to dry at times, and may be useful to reclaim such areas; considered good fodder (crude protein, 11.28%). Can be used for thatching. Also ssp. *echinulatus* (Nees) Cope syn. *C. echinulatus* (Nees) Wats., found on the North-West Himalayas from Kashmir to Nepal, at 1700–3000 m; also reported from Rajasthan. Eaten by cattle.

C. aucheri Stapf syn. *A. aucheri* Boiss. (protein, 4.09%), found in Jammu & Kashmir, Uttar Pradesh and Gujarat and grows in desert and on rocks, *C. lancearius* Haines syn. *A. lancearius* Hook. f. (Bihar–*Korpobimbu*) (crude protein, 4.7%), found in Assam, Sikkim Himalayas, West Bengal, Bihar, Orissa, Madhya Pradesh and Uttar Pradesh in shady and rocky hills, up to 1500 m, *C. orientalis* (Desv.) A. Camus syn. *A. wightianus* Nees ex Steud.; Hook. f. (Fl Br Ind) in part (Tel–*Karrappagaddi*) (crude protein, 4.45%), common in peninsular India, up to 2130 m, Orissa and Assam, *C. polyphyllus* Blatter & McCann syn. *A. polyphyllus* Hook. ex Hook. f., found in Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Bihar, Assam, Andhra Pradesh and Tamil Nadu, and *C. verticillatus* Trin. ex. Steud. syn. *A. verticillatus* Roxb., found in Tamil Nadu, Karnataka, Andhra Pradesh and Orissa, at 600–900 m, are perennial grasses, grazed by cattle.

CLITORIA Linn. (*Fabaceae*)

Erect or climbing, ornamental, perennial herbs or under shrubs; tropics and subtropics; 6 spp in India.

C. ternatea Linn. CONCHFLOWER CREEPER, BUTTERFLY-PEA

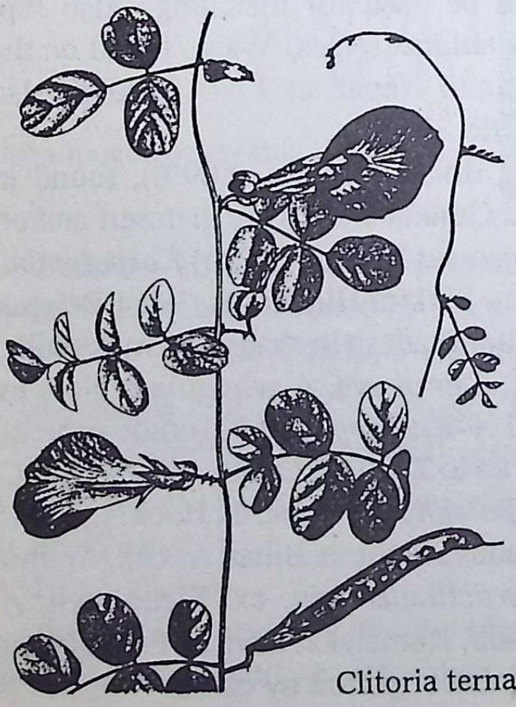
Beng, Hindi, Oriya & Sans–*Aparajita;* Guj–*Bismar;* Kan–*Billisatuga, shankhapushpa;* Mal–*Malai-amukki, sankhupushipi;* Mar–*Gokurna;* Sans–*Aparajita, sankhupushpi;* Tam–*Kakattam;* Tel–*Neela-ghentana, sankhupuvuu.*

Punjab–*Dhanattar;* Rajasthan–*Tithlimattar.*

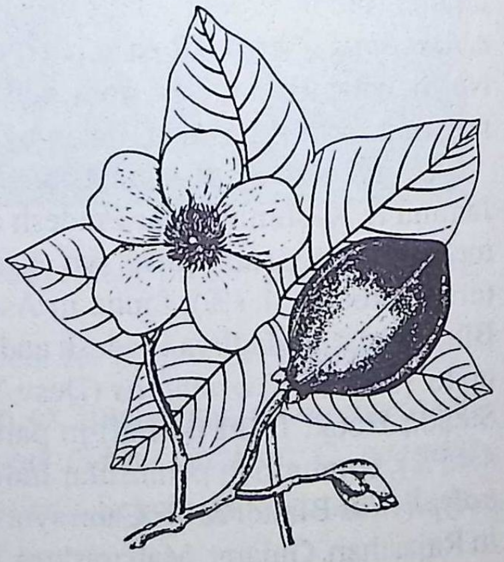
Habit—A perennial climber, up to 3 m. *Stem*—slender, round, hairy, branches, up to 90 cm long. *Flower*—solitary, axillary, pure white or bright blue with white or yellow or orange centre, or sometimes purple, pale blue or mottled blue. *Fruit*—compressed, oblong, stipitate, 6–11-seeded pod, 5–10 cm long. *Seed*—compressed, smooth, yellow, mottled with black, minutely pitted. *Flowering & Fruiting*—June–February.

Distribution and Ecology—Throughout India, up to 1500 m, and in the Andamans; grown for its ornamental flowers. Found as an escape in hedges and thickets and on variety of soils; grows wild in forests also.

Cultivation/Regeneration—Grown from seed sown during July–August; grows well in equal parts of loam, leaf-mould, peat and sand. Starts yielding green fodder within two months..



Clitoria ternatea



Cochlospermum religiosum

UTILIZATION

Reclamation—Being introduced as a drought-resistant legume in pastures of arid and semi-arid regions of Rajasthan and elsewhere. Can also be grown as green manure and cover-crop. Suppresses many weeds. Fixes nitrogen. Suitable for cultivation in Punjab, Rajasthan, Uttar Pradesh, Gujarat, Maharashtra, Madhya Pradesh, Tamil Nadu and Karnataka.

Fodder—Supplies green fodder throughout the year, particularly during the dry period; can be converted into hay (crude protein, 22.6%).

Others—*Leaf & Pod:* Edible. *Root & Leaf:* Laxative, diuretic. *Flower:* Extract of blue flowers used for colouring and as substitute for litmus. *Seed:* Powerfully cathartic (protein, 38.4%). Contains oil (10.2–18.8%) and water-soluble mucilage (8%).

COCHLOSPERMUM Kunth (*Cochlospermaceae*)

Mostly xerophytic, deciduous shrubs or trees, with stout, tuberous underground stems; tropics; 1 sp in India.

C. religiosum (Linn.) Alston syn. *C. gossypium* DC. YELLOW SILKCOTTON TREE

Beng–*Gabdi;* Hindi–*Kumbi;* Kan–*Arasinabooruga;* Mal–*Appakutakka;* Mar–*Ganeri;* Oriya–*Kondopalas;* Tam–*Kongilam;* Tel–*Adavibooruga, kondabooruga*.

Mundari–*Galgal daru;* Oran–*Galgal*.

Habit—A small to medium, quick-growing, naked, soft-wooded, many-branched tree, up to 6 m. *Stem*—stout, young ones covered with soft down. *Bark*—smooth, ash-coloured, fibrous, deeply furrowed. *Leaf*—palmately-3–5-lobed, cordate at base, dark green above, tomentose, 15–30 cm, serrate. *Inflorescence*—terminal panicles in cluster; December–April. *Flower*—bright golden-yellow, up to 8 cm broad. *Fruit*—obovoid, capsule, 5–10 cm across, reddish before drying; March–July. *Seed*—small, reniform, brown, embedded in silky wool; 13,400/kg; germination up to 30%.

Distribution and Ecology—From Garhwal to West Bengal, Orissa, Madhya Pradesh and the peninsular India, up to 900 m; often cultivated for ornament. Occurs in dry forests, particularly hot, dry and stony regions; withstands forest-fires.

Cultivation/Regeneration—Propagated from seed; can be transplanted when seedlings are 30 cm high; inclined to be slender and tall in cultivation; thrives well in gardens.

UTILIZATION

Reclamation—Highly recommeded for reclamation and afforestation of bare, rocky, stony and denuded hills; withstands fires.

Fuel—Useful even when green; used for torches.

Others—Bark: Yields a cordage-fibre. Broken limbs of cattle are poulticed. Also yields a gum, KATIRA GUM, similar to KADIYA (*Sterculia urens* Roxb.); used as a substitute for tragacanth (*Astragalus gummifer* Labill.); useful in cigar-paste, ice-creams; calico-printing, marbling of paper and leather-dressing, and for polishing *tasar*-silk. Gum sweet, astringent, cooling, sedative and useful in cough, diarrhoea, dysentery. As a laxative, superior to agar-agar. *Leaf & Flower:* Stimulant; boiled tender leaves used as cooling hairwash. *Fruit:* Tender fruits boiled and eaten. *Floss:* Soft, resilient; substituted for JAVA KAPOK (*Ceiba pentandra*) or INDIAN KAPOK (*Bombax ceiba*) for stuffing mattresses, pillows, cushions and for life-belts. *Seed:* Kernel (protein, 20.94%) sweet, almond-like flavour or slightly bitter; roasted and eaten; also soaked, pounded and mixed with flour, fried and eaten. Yields a slightly bitter, non-drying oil (15.0%), used for soap-making. *Cake:* Useful for feed and manure.

COLOPHOSPERMUM Kirk ex J. Leon. (*Caesalpiniaceae*)

Probably monotypic trees; river-valleys of Central and South tropical Africa; introduced into India.

C. mopane (Kirk ex Benth.) Kirk ex J. Léon. MOPANE, RHODESIAN IRONWOOD-TREE

Habit—A small or medium-sized tree, 23 m/3 m, becoming round shrub when heavily grazed. *Bark*—rough, dark grey, longitudinally fissured. *Leaf*—2-foliotate: leflets reniform, markedly asymmetrical, look like butterflies, drooping when hot, scented, leathery. *Flower*—small, white or pale green, in slender, pendent, racemes; March. *Fruit*—oblique-elliptic or falcate-ovate, pendent, compressed or turgid, thinly leathery, 1-seeded; June–August. *Seed*—yellowish, kidney-shaped, resin-dotted, wrinkled.

Distribution and Ecology—Native to Central and South Africa, introduced into Rajasthan and cultivated. Generally grows in shallow, compacted, clay, alkaline and badly drained soils; but grows best on rich, deep, alluvial soils. Does well with 200–450 mm rainfall, although grows with a rainfall of 125–800 mm.

Silvicultural Characters—Withstands high temperatures of 36°C and mild frost; heavy frost may cause the branches to die back. Produces rootsuckers. Vigorously coppices after fire, frost or felling. Cannot compete with weeds except under very dry conditions. Growth slow in arid climate.

Cultivation/Regeneration—Reproduces well with seed and can be transplanted; rootsuckers also help to regenerate.

UTILIZATION

Reclamation—Recommended for reclaiming and afforesting the soils mentioned above. In Rajasthan, it is grown on sandy soils under arid conditions and profusely regenerates. Has remarkable ability to tolerate dry, saline soils and also important to stabilize dry, alkaline soils and sand-dunes. Included for aerial seeding in Rajasthan which was successful. Presence of it indicates that soil is otherwise unsuitable for crops.

Timber—Becomes harder when dries. Construction, pestels, mineprops; fenceposts, piles for bridge, railroad ties, carving, and parquet.

Fuel—Excellent fuel with negligible ash; slowly burns and quickly releases large amount of heat for a long time. Makes excellent charcoal.

Fodder—Young shoots and leaves (protein, 6.56–13.7%) readily consumed by livestock and wildlife without any adverse effect on milk or meat. Slightly purgative.

Others—Bark: Yields a fibre, tannins(5.9–8.7%) and a COPAL; copal can be used in varnishes. Tannins can be used for tanning leather. *Root:* Infusion given for expelling tapeworm. Contains a resin.

COMMIPHORA Jacq. (*Burseraceae*)

Thorny, balsamiferous trees and shrubs; Africa and tropical Asia; 6 spp in India.

Some species yield a gum-resin of commercial importance.

C. wightii (Arn.) Bhandari syn *C. mukul* Engl.; *Balsemodendrum mukul* Hook. ex Stocks INDIAN BEDELLIUM TREE

Beng, Guj & Hindi–*Guggul;* Kan & Mar–*Guggule;* Tel–*Guggulu;* Tam–*Maishagukkal*.

Habit—A much-branched, small tree or shrub; young parts glandular, pubescent; branches knotty and crooked ending with thorns. *Stem*—narrow. *Bark*—silvery or ash-coloured, papery. *Leaf*—alternate, 1–3-foliolate: leaflet sessile, 20 mm × 8 mm, rhomboid-ovoid, serrate near apex, lateral leaflets when present much smaller, smooth, shining. *Flower*—solitary or 2–3, in fascicles, unisexual, brownish-red. *Fruit*—ovoid drupe, 6–8 mm broad, red when ripe. *Seed*—2 stones. *Flowering & Fruiting*—October–December.

Commiphora wightii

Distribution and Ecology—Rajasthan, Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu; sometimes planted in hedges. Common on open, dry, rocky, arid wastelands and hills, pale-brown to light, gravelly, somewhat-compact, non-calcareous loamy, sandy soil with profuse roots overlying down to 30 cm deep. Planted as a hedge.

UTILIZATION

Reclamation—Recommended for arid rocky, and semi-rocky tracts and can be grown for reclaiming the wastelands in arid regions, particularly in Rajasthan.

Others—Bark: Exudes a pale-brown or dull-green gum-resin in cold season, called *guggul* or INDIAN BEDELLIUM, used as an adulterant toMYRRH. Used in perfumery as fixative and as incense. Contains an essential oil (1.45%) and resin (up to 61%). Bitter, aromatic, antiseptic for wounds and ulcers, emmenagogue, carminative, diaphoretic, expectorant, diuretic, astringent, laxative, analgesic and uterine stimulant. Useful in various neurological disorders, liver complaints, heart-diseases, sciatica and piles. *Guggul* improves digestion in chronic dyspepsia, chronic rheumatism, chronic nasal catarrah, chronic laryngitis; given for gargling for weak and spongy gums and pyorrhoea. Inhalation of burnt *guggul* helps in chronic bronchitis, and phthisis. Essential oil anthelmintic and antibiotic.

C. berryi (Arn.) Engl. syn. *B. berryi* Arn. is a small, fragrant tree, found in Tamil Nadu, grown as a hedge. *C. caudata* (Wight & Arn.) Engl. syn. *Protium caudatum* Wight & Arn. (HILLMANGO, Kan–*Kondamavn;* Tam–*Kiluvai;* Tel–*Kondamaamidi*) is a handsome tree, found in the peninsular India, grown in avenues; needs no attention.

CYMBOPOGON Spreng. (*Poaceae*)

Perennial, tufted grasses; Old World tropics; 20 spp in India.

Most of them yield essential oil; some medicines and a few fodder.

C. citratus Stapf syn. *Andropogon citratus* DC. THE WEST-INDIAN LEMONGRASS

Beng–*Gandhabena;* Guj–*Lilicha;* Hindi–*Gandhatrina;* Kan–*Majjigehullu;* Mal & Tam–*Vaasanappulla;* Mar–*Hirvacha;* Sans–*Bhustrina;* Tel–*Nimagaddi.*

Punjab–*Khawi.*

Habit—A tall, tufted perennial. *Culm*—stout, erect, 2 m. *Leaf*—linear, attenuate towards the base, tapering, 1m long, glabrous, green. *Inflorescence*—racemes, with sessile spikelet.

Distribution and Ecology—Reported wild in Karnataka; grown in gardens of Punjab, Gujarat and Maharashtra. Flourishes on well-drained soil, on arid, light-coloured, micaceous loam, with a rainfall of 2000–2500 mm.

Cultivation/Regeneration—Clumps divided into slips and planted at 60–90 cm during rains; harvested after 6–9 months first time and 3 times a year later. Replanting is necessary after 3 years.

UTILIZATION

Reclamation—Can be planted on the soils mentioned above for reclamation.

Fodder—Grass, divoid of essential oil, is superior to cereal straw in palatability and nutritive value.

Others—Grass: Yields an essential oil (0.20%); useful in perfumery; possesses antimicrobial, anthelmintic, insect- and housefly-repellent and fumigant properties. May be used for the commercial production of vitamin-A.

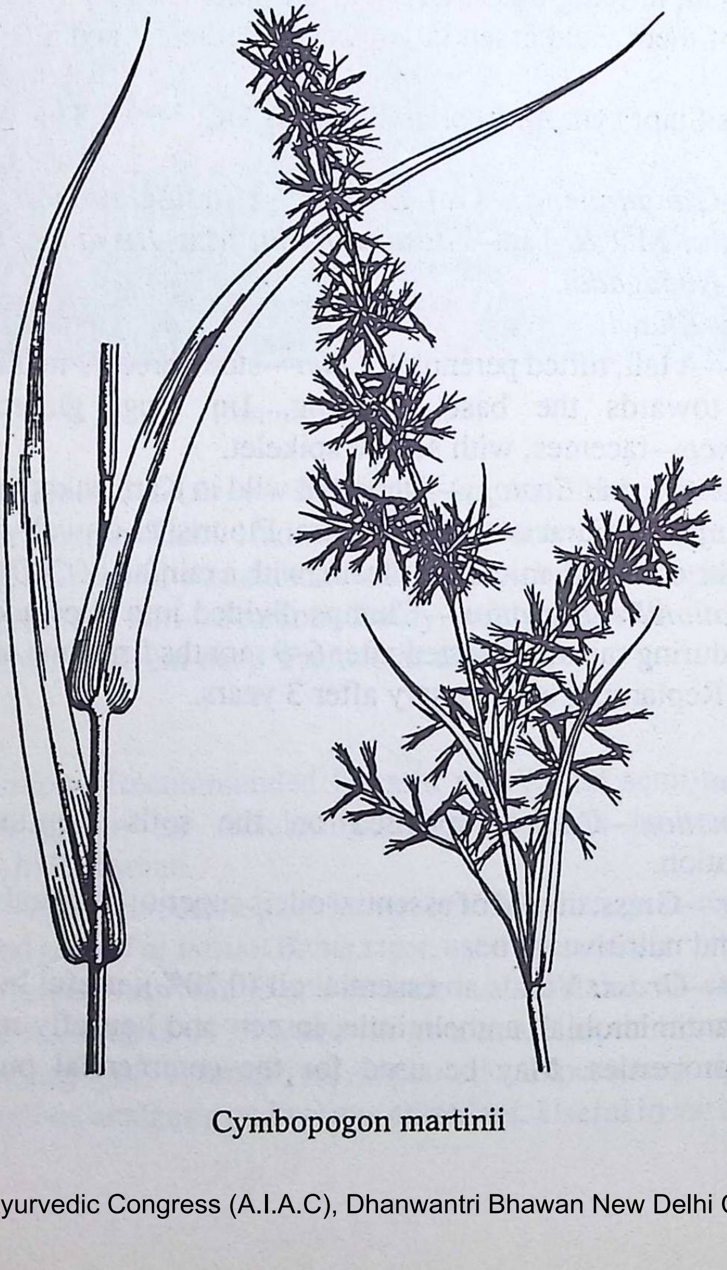
C. flexuosus (Steud.) Wats. syn. *A. nardus* Linn. var. *flexuosus* Haek.
THE EAST-INDIAN MALABAR OR COCHIN LEMONGRASS

Mal–*Kodipullu.*

Habit—A tall perennial. *Culm*—erect, with reddish-purple tinge. *Leaf*—rounded or cordate at base, purple-tinged, 0.8–1.0 cm broad. *Inflorescence*—racemes reddish-purple or greenish, with sessile spikelet.

Distribution and Ecology—Found in Kerala and Tamil Nadu. Grows best on well-drained sandy loam or light sandy soils. Though dark, heavy, rich soils encourage good growth, oil contains less citral; also grows on slopes; cultivated in forest-clearings or hillslopes.

Cultivation/Regeneration—Ploughed during March–April and seed broadcast; germinates during monsoon and ready for cutting during



Cymbopogon martinii

May–June for regular harvesting. Stubbles are burnt before rains for fresh shoots; weeding and protection from grazing are essential. Plantations can be maintained for 6–8 years.

UTILIZATION

Reclamation—Can be grown for reclaiming the forest-clearings and hillslopes; roots survive even after drying or burning. Recommended for social forestry.

Fodder—Grass without essential oil makes good roughage (crude protein, 5.4%).

Others—Grass: Yields an essential oil (0.25–0.5%); used in perfumery, soaps and cosmetics and as a mosquito-repellent; oil also exported; possesses antimicrobial, anthelmintic and sedative properties.

C. jwarancusa Schult. syn. *A. jwarancusa* Jones; *A. laniger* Duthie, non Desf.

Beng–*Karankusa.*

Habit—A highly aromatic grass, with densely tufted roots, 1.8 m. *Stem*—from the clusters of firm, persistent, finally loose and open sheaths. *Leaf*—flat, narrowly linear, 60 cm × 5 mm. *Inflorescence*—panicle. *Spikelet*—3–4 pairs, green.

Distribution and Ecology—On the Himalayas from Kashmir to Assam, up to 3240 m and in the North-western plains of arid Rajasthan, in mixed xeromphic thorny forest, on hills and rock outcrops and on sand-dunes, extending into Maharashtra.

UTILIZATION

Reclamation—Useful to grow on sand-dunes, and on rangelands. Recommended for social forestry.

Fodder—Useful for forage.

Others—Grass: Yields an essential oil; exhibits good antimicrobial properties.

C. martinii (Roxb.) Wats. syn. *A. martinii* Roxb.; *A. schoenanthus* Linn. var. *martinii* Hook. f. ROSHA OR RUSAGRASS

Guj–*Rauns;* Hindi–*Gandhibel;* Mar–*Roshegavat;* Tam–*Kavathampillu.*

Habit—A tall, sweet-scented, perennial grass, 2.4 m. *Culm*—erect, leafy, glabrous, 1.5 m tall. *Leaf*—lanceolate or linear-lancelote. *Inflorescence*—decompound panicle of spiciform racemes.

Cultivars—Two cultivars 'Motia' (PALMAROSA, RUSA OR THE EAST-INDIAN GERANIUM OIL, *c.* 1.4%) and 'Sofia' (GINGERGRASS OIL) exist and grow under different conditions.

Distribution and Ecology—Drier localities from Kashmir to Uttar Pradesh, Bihar, Madhya Pradesh and Rajasthan, extending into peninsular India. Grows in open forests or clearings on dry, sunny slopes, at lower altitudes and valleys, in shady canals and dense, moist areas with poor drainage. Frost reduces the oil.

Cultivation/Regeneration—Harvesting can be from fourth week of October to third week of November. Stubbles are burnt after harvest; regenerate again in March; mature grass with flower harvested for distillation.

UTILIZATION

Reclamation—Has soil-binding capacity and can be used in reclaiming soils prone to erosion and can be improved. Since the plant withstands the fires and again flushes with moisture, its utility in afforestation is highly important; also grows on soils with poor drainage.

Others—Grass: Yields an essential oil; from 'Motia' is used in perfumery and cosmetics; also as adulterant to *Attar-of-Roses*; inhibits growth of *Aspergillus parasiticus* on stored grains. Useful in medicinal preparations for lumbago and stiff joints and in skin-diseases; said to cure baldness; given in bilious complaints. Oil from 'Sofia' chiefly used in soap-perfumes.

C. schoenanthus Spreng.

Beng–*Gandhabena;* Hindi–*Rousaghas;* Mal–*Shankaranepillu.*

Habit—An erect glabrous, perennial grass. *Leaf*—filiform, channelled, 30 cm × 20 mm, basal sheaths straw-coloured. *Inflorescence*—narrow panicle, up to 30 cm long, 4–7-noded. *Spikelet*—fertile, elliptic, lanceolate, 4–5 mm long.

Distribution and Ecology—Kashmir, Punjab , Rajasthan, Gujarat and Maharashtra. Psamophyte, adapted to arid tract and a typical species of desert, found on dry, sandy tract, with 250–300 mm rainfall.

UTILIZATION

Reclamation—Since the grass is typical of desert, useful for stabilizing arid tract and sand-dunes.

Fodder—Yields a good fodder.

C. caesius Stapf syn. *A. caesius* Nees; *A. schoenanthus* Linn. var. *caesius* Hack.; *A. gracillimus* Hook.; f. (Kan–*Kaamanchahullu;*

Mal–*Inchipul;* Tam–*Kaamati, kaamakshipillu;* Tel–*Kaamachigaddi*) is a perennial grass, found in India; grows on poor, light soils. Yields an oil similar to that from *C. martinii* 'Motia'. Oil exhibits antibacterial properties. *C. parkerii* Stapf, found in Uttar Pradesh and Rajasthan desert, is a useful fodder.

CYNODON Rich. (*Poaceae*)

Creeping perennial grasses; tropics and subtropics; 4 spp in India.

C. dactylon Pers. BERMUDA- OR BAHAMA-GRASS, DHUBGRASS

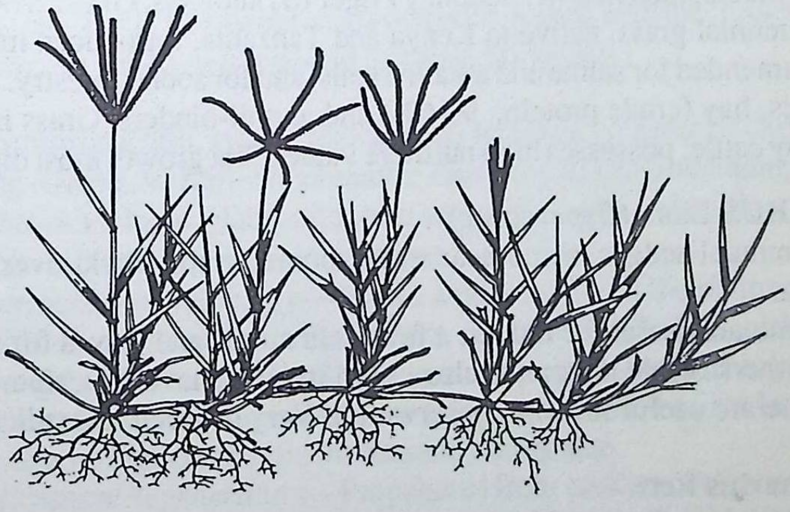
Beng–*Durba;* Hindi–*Dhub, hariali;* Kan–*Garikaihallu;* Mar–*Durva, haryali;* Sans–*Durva, haritali;* Tam–*Arugampullu;* Tel–*Garikagaddi.*

Punjab–*Dhubkhabbal.*

Habit—A very hardy, perennial grass, with creeping culms, rooting at nodes, forming thick, spreading mats on and under the surface of soils, greatly varying according to soil and climate. *Leaf*—short, soft, linear to lanceolate. *Inflorescence*—spikes digitate or finger-like, with 1-flowered spikelets.

Distribution and Ecology—Throughout India, up to 2400 m. Grows very well and forms turf on well-drained, fertile, clay-loamy soils, with high humidity and intermittent rains; abundant on roadsides and paths; can readily grow on any land if not cultivated, even on sandy loam, alluvial, red and black soil, with a pH range from 5.5 to 8.0; highly tolerant to saline, sodic and alkaline soils.

Cultivation/Regeneration—Grown from hulled seed or stolons or



Cynodon dactylon

rhizomes; rooted cutting planted at 30–60 cm apart in furrows and pressed with feet. Planting or seeding in wet weather ensures quick sprouting. Manures and fertilizers at the time of sowing and periodical irrigation in dry period help the growth; ready for harvest after 100 days; normally 4 cuttings possible.

UTILIZATION

Reclamation—Recommended and grown for conservation of soil and erosion-control; forms turfs and lawns; a very good soil-binder grown for clothing the banks where it forms dense mat; very difficult to eradicate as even a small piece of rhizome or node strikes roots and establishes; even on the unused asphalted or gravelled or brick-laid roads and roadsides or even highly polluted soils it sprouts and covers; in waterlogged areas, in Rajasthan deserts, on riverbeds, on alluvial alkaline and saline soils and rangelands, it forms a thick covering. Can be planted as a primary stabilizer of beach-sands; tolerates metalliferous soils. Withstands moderate grazing. Recommended for agroforestry to be grown with *Leucaena latisiliqua*, and for social forestry, for ravines and gullies. Forms one of the best turfs and lawns.

Fodder—Serves as pasture, forage (crude protein, 10.47%), particularly during the summer; hay a good source of vitamin-A for beef-cattle (crude protein, 5.0%) .

Others—Grass: Astringent, diuretic; useful in dropsy and anasarca; applied to bleeding and cuts; possesses cholagogue properties; used in anti-atherosclerotic preparations. *Rhizome & Root:* Substituted for *Ischaemum muticum* in urino-genital disorders.

C. plectostachyum (K. Schum.) Pilger (STARGRASS, GIANT STARGRASS) is a perennial grass, native to Kenya and Tanzania, introduced into India. Recommended for saline and alkaline soils, and for social forestry. Used for pastures, hay (crude protein, 9.16%) and as soil-binders. Grass is readily eaten by cattle; possesses high nutritive value. First growth most digestible.

CYPERUS Linn. (*Cyperaceae*)

Perennial sedges, some near water; common the world over; 60 spp in India.

Some are useful for fodder; a few yield culms and leaves for matting; a few others edible rhizomes; also useful in medicine and perfumery; and yet some are useful for soil-conservation. Very difficult to eradicate.

C. arenarius Retz.

Rajasthan—*Motho*.

Habit—A glaucous-green, pale, rigid, creeping sedge, with wiry, elongated rhizome. *Culm*—distant on the rhizome, stout, rigid, terete, 10–30 cm. *Leaf*—linear, 5–20 cm × 2–3 mm. *Inflorescence*—solitary, terminal heads, more or less globose, brown. *Spikelet*—numerous, radiating, elliptic-lanceolate, dirty straw-coloured ultimately becoming brown, 8–25-flowered.

Distribution and Ecology—In the arid zones and on deep sandy soils of Punjab, Rajasthan, Gujarat, Maharashtra and Orissa.

UTILIZATION

Reclamation—Can be planted to colonize sand-dunes. During summer, it survives through stolons and rhizomes and sprout with the onset of rains.

C. bulbosus Vahl

Kan–*Bhadramaste;* Tam–*Silandiarisi;* Tel–*Puridumpagaddi.*

Habit—A stoloniferous, glabrous, erect perennial, with numerous bulbs. *Bulb*–as small as paddy-grain, very easily separates from parent-plant. *Culm*—slender, trigonous, 10–30 cm long. *Leaf*—many, longer than stem, 4 mm wide at base. *Inflorescence*—subumbellate, interrupted. *Spike*—red. *Spikelet*—4–12, 8–12-flowered.

Distribution and Ecology—Found on sandy situations and commonly in wasteplaces in Rajasthan, Gujarat, Maharashtra, Andhra Pradesh, Tamil Nadu and throughout the coast of India and upper Gangetic basin.

UTILIZATION

Reclamation—Suitable to stabilize sand-dunes.

Others—Bulb: Powdered or roasted bulb, mixed with the flour of *bajra* and *jowar*, is eaten, but reported to cause blindness.

C. corymbosus Rottb. syn. *C. tegetiformis* Roxb.; *C. tegetum* Roxb. in part

Beng–*Golmethi;* Kan–*Bhadrehullu;* Tam–*Korai;* Tel-*Goddutungakoodu.*

Habit–A variable, glabrous, robust sedge. *Rhizome*—creeping, woody. *Culm*–60–150 cm, arising from rhizome.

Distribution and Ecology—Grows wild throughout the plains of India, up to 1800 m, particularly in the eastern and southern India; cultivated in West Bengal and Tamil Nadu. Grows in marshy situations, on heavy clayey soils, deficient in drainage and on low-lying swamps and saline lands unfit for any other crop; can be grown on sandy soils also.

Cultivation/Regeneration—Propagated from suckers or slips with bulbs containing short lengths of culms. About 33,000 bundles of 10–12 slips needed for each hectare, planted at 10–13 cm apart; manuring helps; 2–3 weedings given in the first year and one each in subsequent years; once established continues to yield up to 10–15 years. Ready for harvest in *c*10 months and harvested before the flower-heads dry up, dried and sorted out into different sizes.

UTILIZATION

Reclamation—Recommended for reclaiming the soils mentioned above.

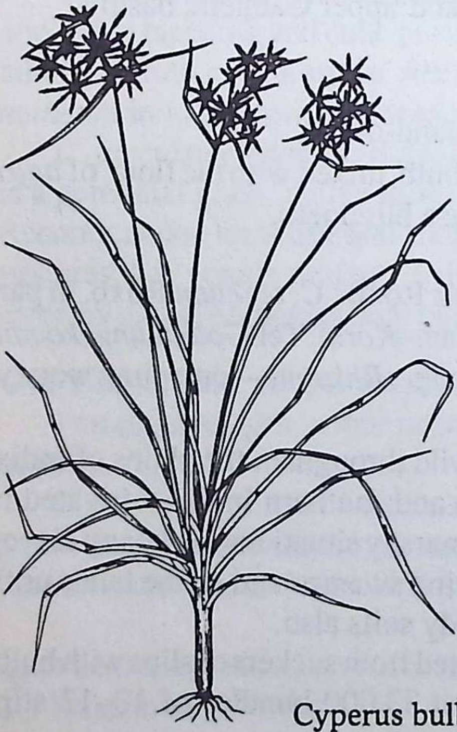
Others—*Culm:* Used for mats.

C. iria Linn.

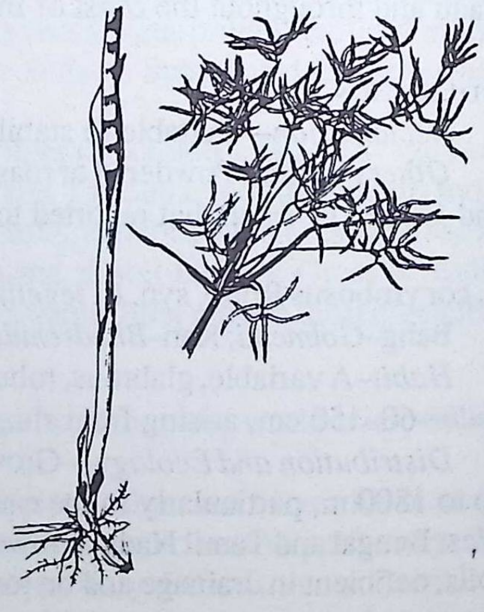
Kan—*Dabbejambuhullu.*

Habit—A short-lived, tall annual, with fibrous roots. *Stem*—up to 60 cm, triquetrous. *Culm*—tufted, triquetrous, 30–50 cm. *Leaf*—as long as or shorter than culm, 5 mm wide, few, scabrid towards apex. *Inflorescence*—large, compound umbels, 5–20, spicate. *Spike*—cylindrical, lax. *Spikelet*—compressed, linear, oblong; September. *Fruit*—obovate-elliptic, with concave, smooth sides; around November.

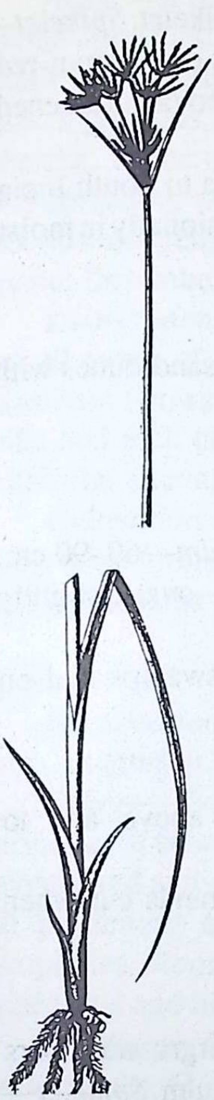
Distribution and Ecology—Throughout India. Grows on saline soils, riverbeds and other soils. Common weed of paddy-fields and other wet places.



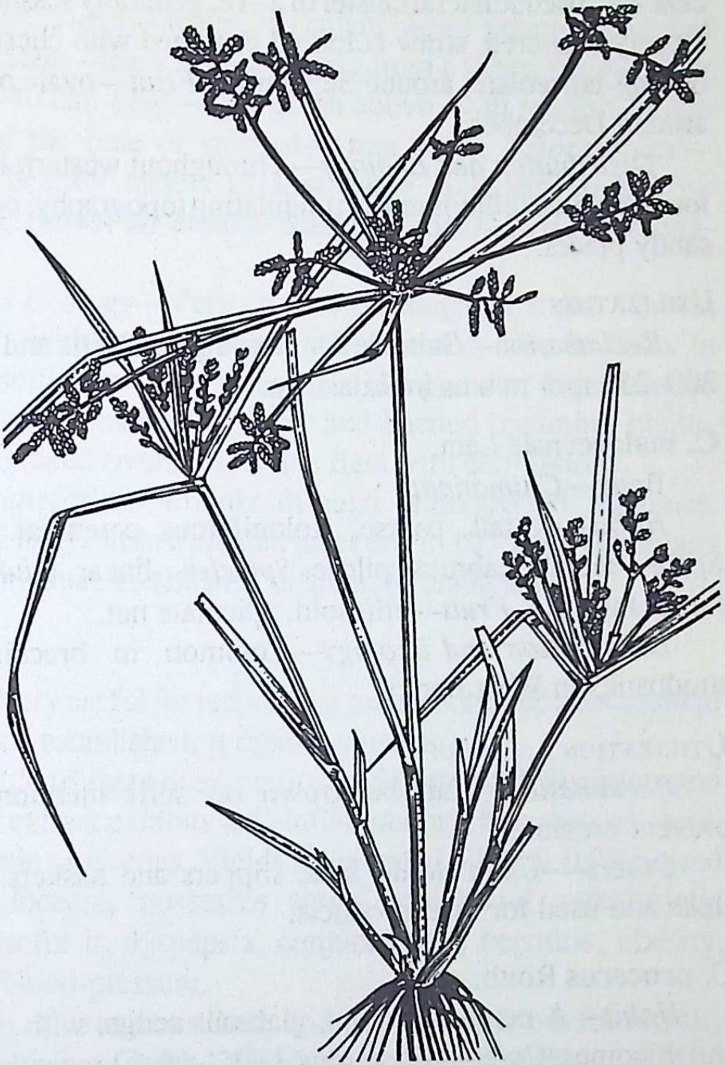
Cyperus bulbosus



C. corymbosus



C. scariosus



C. iria

UTILIZATION

Reclamation—Recommended for marshy wastelands, saline flats, depressions and graded riverbeds in Rajasthan.

Fodder—Culm useful as fodder (crude protein, 6.04%), and for mats.

Others—*Rhizome:* Astringent, contains an essential oil.

C. laevigatus Linn. syn. *Juncellus laevigatus* C. B. Clarke

Habit—A perennial sedge. *Rhizome*—creeping, densely covered internodes with chestnut or red scales. *Stem*—10–30 cm, rigid, compressed, trigonous. *Culm*—up to 1m. *Leaf*—sometimes as long as stem. *Inflores-*

cence—pseudolateral cluster of 2–12, generally sessile spikelet. *Spikelet*—closely clustered, straw-coloured or tinged with chestnut or chestnut-red, oblong-lanceolate; around September. *Fruit*—ovate or obovate, flattened; around December.

Distribution and Ecology—Throughout western India to South India, found on older alluvium with undulating topography; occasionally in moist, sandy places.

UTILIZATION

Reclamation—Suitable for growing in deserts and on sand-dunes with 200–250 mm rain as in Rajasthan.

C. malaccensis Lam.

Beng—*Chimatipati*.

Habit—A tall, coarse, stoloniferous perennial. *Culm*—60–90 cm. *Spike*—rachis scabrous, pilose. *Spikelet*—linear. *Glume*—ovate, slightly larger than nut. *Fruit*—ellipsoid, apiculate nut.

Distribution and Ecology—Common in brackish swamps and on mudbanks in West Bengal.

UTILIZATION

Reclamation—Can be grown on soils mentioned above and to prevent erosion.

Others—*Culm:* Mats, hats, slippers and baskets. Strands cut when fresh and used for finer products.

C. procerus Rottb.

Habit—A perennial, stout, glabrous sedge, with underground tubers and rhizomes. *Culm*—triquetrous. *Leaf*—often longer than culm. *Spikelet*—sometimes tinged red or bright red or straw-coloured. *Fruit*—obovoid, trigonous, yellow-brown nut.

Distribution and Ecology—Grows near the sea, in paddy-fields and swampy areas in West Bengal. Hardy and can withstand drought and waterlogging. Difficult to eradicate.

Cultivation/Regeneration—From seed and underground stems.

UTILIZATION

Reclamation—Can be grown to reclaim seacoast and swampy areas.

C. rotundus Linn.

Beng, Guj, Hindi & Mar–*Motha;* Kan–*Tungehullu;* Tam–*Korai;* Tel–*Tungagaddi*.

Habit—A perennial, stoloniferous, rhizomatus, halophytic sedge. *Rhizome*—many, slender. *Tuber*—white, succulent when young, hard and black when mature. *Stem*—leafy at base arising from a tuber. *Culm*—dark green, glabrous, 15–40 cm. *Leaf*—dark green above, with reddish-brown sheaths, clustered at the base of stem, 4–8 mm wide. *Inflorescence*—3–9 spreading-rays bearing tassels of few, large spikelets. *Spikelet*—20–40-flowered, red-brown to almost black; October. *Fruit*—oblong-ovate; December.

Distribution and Ecology—Very common throughout India. Thrives on all types of soils with varying climatic conditions; also in lakes in Kashmir. Grows on soils from waterlogged to arid regions of Rajasthan, on hills and rock outcrops, sandy soils, lower and burried piedmont plains, older flat alluvium, graded riverbeds, saline flats with depressions.

Cultivation/Regeneration—Mainly through underground rhizomes. New tuber forms in 21 days from a planted tuber and in 105 days 146 tubers and basal bulbs form. Once established difficult to eradicate.

UTILIZATION

Reclamation—Very useful for reclaiming soils mentioned above and to prevent erosion. Once established, it rapidly spreads.

Others—Tuber: Astringent diaphoretic; used in stomach disorders and irritation of bowels; extract exhibits anti-inflammatory, hypotensive, antipyretic and anti-emetic properties. Yields an essential oil (0.5–0.9%), used in perfumery and incense; possesses antimicrobial and anthelmintic properties. *Root:* Useful in dyspepsia, conjunctivitis, hepatitis, obesity, giardiasis and high blood-pressure.

C. alulatus Kern., *C. exaltatus* Retz. and *C. papyrus* Linn. for marshy wastelands; *C. brevifolius* (Rottb.) Hassk.(=*Kyllinga brevifolia* Rottb.) Linn., an erect grass up to 60 cm, found throughout India, suitable for growing in soft, sticky soil along the banks of streams and other wet places; readily eaten by cattle; *C. compressus* Linn., *C. cuspidatus* Kunth and *C. pulchellus* R.Br. for damp, sandy soils; *C. pangorei* Rottb. for marshes and on rocky margins of streams and *C. rubicundus* Vahl for rocky forest-areas have been recommended; *C. scariosus* R.Br. (Beng & Hindi–*Nagarmutha;* Mar–*Lawla;* Tam–*Koraikkilangu*), a delicate sedge, met with in damp places in West Bengal, Uttar Pradesh and South India; tuber yields a pleasant essential oil (0.075–0.080%); and *C. stoloniferus* Retz. (Tam & Tel–*Jataamansi*), with long stolons, occurs on seashores; serves as a sand-binder; tubers used in perfumery and considered stomachic and stimulant to heart.

DALBERGIA Linn. f. (*Fabaceae*)

Trees, shrubs and woody climbers; tropical and subtropical regions; 2 spp in India.

D. latifolia Roxb. THE EAST-INDIAN ROSEWOOD OR BLACKWOOD

Beng–*Sitsal;* Guj, Hindi & Mar–*Shisham;* Kan–*Bite;* Mal & Tam–*Itti;* Oriya–*Sisua;* Tel–*Irugudu, cittegi.*

TRADE—*Indian Rosewood* or *Bombay Blackwood* .

Habit—A large, deciduous or nearly evergreen tree, with rounded crown, up to 40 m/6 m. *Stem*—cylindrical, with fairly clear bole, up to 21 m. *Bark*—fairly thin, grey, exfoliating in thin, longitudinal flakes. *Leaf*—20–25 cm: leaflets elliptic-orbicular. *Flower*—small, white, scented in lax, axillary panicles; around September; may also depend upon locality. *Fruit*—firm, strap-shaped, 1–3-seeded pod; December–April. *Seed*—18,500–40,000/kg; germination 21 days, 45–80%; viable for 1–12 months.

Distribution and Ecology—In the sub-Himalayan tract from Uttar Pradesh eastwards to Bihar, Orissa and Central and peninsular India. Grows on gnessis, laterite, boulder-deposits and alluvial formation and thrives on well-drained, deep, moist soil, particularly near perennial streams; grows fairly well on black cotton-soils and on poor, dry, stony soils.

Sivicultural Characters—Generally a moderate light-demander, but when young, withstands fair amount of shade. Drought-resistant. Does not tolerate bad drainage. Withstands fire. Produces several rootsuckers as wounding also stimulates. Coppices well. In too open situations, tends to become crooked and branchy. Protection from grazing is also needed.

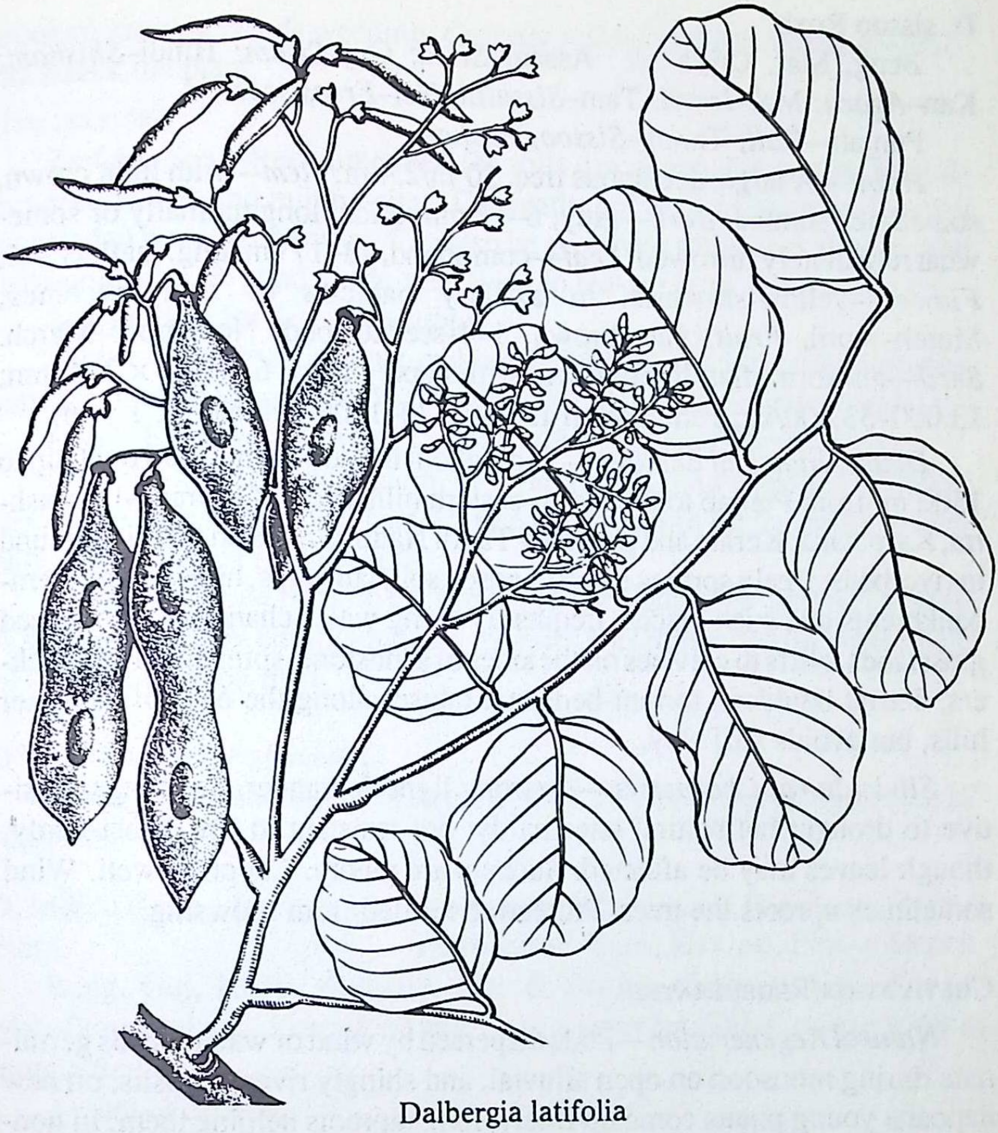
CULTIVATION/REGENERATION

Natural Regeneration—Regenerates from seed in the early part of rainy season; rootsuckers plentiful in exposed situation and prolific regeneration occurs.

Artificial Regeneration—Can be from direct sowing, transplanting, rootsuckers, root- and stem-cuttings, and stump-planting or nursery-raised seedlings. For direct sowing, seed is sown at 45 cm × 3.6 m; for transplanting, seed is sown in raised, porous loam in March or April in drills of 30 cm or 45 cm lines; weeded and shaded; transplanted in first or second rains after pruning the stem (5 cm) and root (15–30 cm). For exclusive plantation, spacing should be 4.5 m apart, thinning to 9 m. A few fungi have been recorded.

UTILIZATION

Reclamation—Can be grown on poor, dry, stony soils, waterlogged



Dalbergia latifolia

soils and the grassy blanks as it has good capacity to grow. Recommended for block-planting, shelterbelts and windbreaks and for shade and social forestry. For agroforestry, 30 cm space is needed for growing with millet. Fixes nitrogen.

A host for *Santalum album*.

Timber—One of the finest woods for cabinet-work, pianoes, decorative wood for ornamental plyboards and veneers, carts, printing-motifs, agricultural implements, window-frames, doors, etc. Suitable for making hardboard, plywood and pulp.

Fodder—Leaf lopped for fodder.

Others—Bark: Yields tannins.

D. sissoo Roxb.

Beng, Mar, Oriya & Assam–*Sissu;* Guj–*Sisam;* Hindi–*Shisham;* Kan–*Agaru;* Mal–*Iruvil;* Tam–*Sissuitti;* Tel–*Errasissoo.*

Punjab—*Tali;* TRADE–*Sissoo, shisham.*

Habit—A large, deciduous tree, 30 m/2.4 m. *Stem*—with light crown, sometimes stunted. *Bark*—grey, 6–12 mm thick, longitudinally or somewhat reticulately furrowed. *Leaf*—compound, 13–17 cm long: leaflets 3–5. *Flower*—yellowish-white, in axillary panicles of short racemes; March–April. *Fruit:* pale brown, 1–4-seeded pod; November–March. *Seed*—reniform, flat, light brown, with papery testa, 6–8 mm × 2–4 mm; 13,000–53,000/kg; germination 15 days, 70–100%; viable for 1 year.

Distribution and Ecology—Throughout the sub-Himalayan tract, up to 1500 m, from Punjab to the North-eastern hills and in Gujarat, Maharashtra, Karnataka, Kerala and probably Tamil Nadu. Grows on alluvial ground in riverbeds; freely springs up on exposed soil, landslips, hillsides, new embankments and such places, frequently along water-channels, on exposed grasslands, cliffs to crevises on the sides of sandstone, spreading from suckers, detrial boulders, torrent-beds and taluses along the base of the outer hills, but avoids stiff clay.

Silvicultural Characters—A strong light-demander. Seedlings sensitive to drought but natural ones hardy; not resistant to fire. Frost-hardy, though leaves may be affected. Suckers are plenty. Coppices well. Wind sometimes uproots the trees. Protection needed from browsing.

CULTIVATION/REGENERATION

Natural Regeneration—Pods dispersed by wind or water. Seeds germinate during monsoon on open alluvial, and shingly river-deposits; on new deposits young plants come up freely, long taproots helping them. In non-riverain tracts also, it regenerates in open on newly exposed grounds, on new embankment, landslips, heaps of stones, etc., grassy tracts and on abandoned areas on the sides of channels.

Artificial Regeneration—Easily raised from seed and also from shoot- and root-cuttings and stumps; rootsuckers also highly successful, particularly in dry climate. Direct sowing in lines is much more successful than transplanting; transplanting can be done in filling up gaps and roadside plantation with tender seedlings and short roots; stump-planting can also be adopted in the third week of March. Irrigation depends upon necessity. Stimulation of the roots of the existing plants produces suckers useful in regeneration. A spacing of 1.5 × 3.0 m does not permit low branching and crooked growth. Needs weeding. *Cuscuta reflexa* and *Loranthus longiflorus* attack the plant.

UTILIZATION

Reclamation—Recommended for soils discussed above; also for gullies and ravines and mining-sites. Cultivation of crop under agro-forestry reported to improve the trees. Can also be grown on saline and alkaline and semi-arid soils. A good shade-tree; used in tea-gardens. Fixes nitrogen.

A good host for *Santalum album*.

Timber—Furniture, cabinet-making, buildings, agricultural implements; carriages and wheelwork; and paper-pulp. Yields oleoresin and essential oil.

Fuel—Excellent firewood (5180 kcal/kg); suitable for charcoal.

Fodder—Leaf (crude protein, 17%) and shoot (crude protein, 13.65%) lopped for sheep, goats and camels. Used as a manure for tea-bushes. Contains an antifungal essential oil.

D. sympathetica Nimmo ex Grah. syn. *D. multiflora* Heyne ex Wall. is a large, scandent shrub, found on the hills; recommended for shelterbelts in controlling sand-drift.

DERRIS Lour. (*Fabaceae*)

Woody climbers, shrubs or trees; tropics, chiefly in South-East Asia; 27 spp in India.

D. indica (Lam.) Bennett syn. *Pongamia glabra* Vent.; *P. pinnata* (Linn.) Pierre PONGAM-OIL TREE, KARANJ, INDIAN BEECH

Beng, Guj, Hindi, Kumaun, Mar & Punjab–*Karanja;* Kan–*Honge;* Mal–*Pungu;* Oriya–*Koranjo;* Tam–*Ponga, pongam;* Tel–*Gaanugachettu, punguchettu.*

Assam–*Karchaw.*

Habit—A fast-growing, very variable, medium-sized, glabrous tree, up to 18 m/1·5 m and occasionally more. *Rootsystem*—highly spreading. *Stem*—short bole with a spreading crown and drooping branches, sometimes stunted. *Bark*—greyish-green or brown, smooth or covered with tubercles. *Leaf*—imparipinnate: leaflets 5–7, ovate or elliptic, young vivid lemon-green later darkening. *Inflorescence*—axillary racemes. *Flower*—lilac with white-tinged or pink or white, fragrant; April–June. *Fruit*—compressed, woody, yellowish-grey when ripe, elliptic to obliquely oblong, 4.0–7.5 cm × 1.7–3.2 cm, beaked, usually 1-seeded, rarely 2; November–December to May–June. *Seed*—reddish-brown, reniform or elliptical, wrinkled, 1.7–2.0 cm × 1.2–1.8 cm; viable for at least 1 year; no treatment needed.

Distribution and Ecology—Common almost all over India, up to 1200 m. Found on several types of soils along the stream-and riverbanks or near the seacoast and tidal forests. Grows in dry places far in the interior and wild on sandy and rocky soils including oolitic limestone.

Silvicultural Characters—Adapts well to the extremes of climate, soil and moisture. Very good shade-bearer; gives plenty of shade under which fodder-grasses grow well. Resists drought well. Moderately frost-hardy and highly tolerant to salinity. Rootsuckers many. Coppices well. Can be planted very close and independent of weeds.

CULTIVATION/REGENERATION

Natural Regeneration—Through seed or rootsuckers; runs wild through rootsuckers.

Artificial Regeneration—Though direct sowings usually successful, transplanting the nursery-raised, one-year-old seedlings is done; root- and

Derris indica

shoot-cuttings and layering can also be used in moist areas. Starts bearing at 4 years.

UTILIZATION

Reclamation—A fast-growing tree with aggresively spreading roots, commonly planted for afforestation especially in watershed and arid and semi-arid, dry areas; semi-moist areas and waterlogged areas as mangroves; binds the shifting sand-dunes and checks erosion. Highly tolerant to salinity and can survive even with its roots in salt-water and alkaline lands; can be planted for reclaiming gullies and ravines and mined sites. Planted for shade and ornament, especially along roadsides as an avenue-tree nearly all over India; also planted for shelterbelts. Fixes nitrogen. Leaves and flowers good manure. Suitable for agro- and social forestry. Considered good for planting in pastures as grass grows well under it.

A host for lac-insect.

Timber—Cabinet-work, yokes, carts, ploughs, cartwheels, posts, oilmills, etc. Source of pulp. Ash used in dyeing.

Fuel—Burns well and commonly used as firewood (4839 kcal/kg).

Fodder—Leaf very often lopped for fodder and is rich in protein and highly valued in arid regions.

Others— Bark: Yields a fibre; made into strings and ropes. Given in piles and beri-beri. Extracts showed antibacterial activity. *Leaf:* Rich in nitrogen and utilized for green-manuring; checks nematodes and termites; dried leaves mixed with grains for pest-control. Acts as galactagogue and its juice given in flatulence, dyspepsia, diarrhoea, cough, leprosy and gonorrhoea; hot infusion used in rheumatic pains, cleaning foul ulcers and sores. Yields essential oil with antifungal properties. *Shoot:* Excellent toothbrush; cures pyorrhoea and other diseases of teeth. *Root:* Juice for cleaning foul ulcers and closing fistulous sores; strengthens gums. Possesses piscicidal properties. *Flower:* Decoction quenches thirst in diabetes. Source of pollen for honeybee. Good manure particularly for potted plants. *Seed:* Has hypotensive and uterine-contracting properties; used in skin-diseases, rheumatic pains, bronchitis and cough, and in leprous sores. Yields a bitter, non-edible oil (24–40%) with disagreeable odour; used for illumination, in leather-dressing, soap-making, lubrication after naturalization, varnishes, paints and candles. Karanjin is the active principle; effective against cockroach and housefly; useful in cutaneous affections, herpes, scabies, rheumatism and as stomachic in dyspepsia. Possesses anti-tubercular, anthelmintic, insecticidal and antibacterial properties. *Cake:* May be useful s feed for poultry and cattle (crude protein, 34%) after deoilification and detoxification. Good manure for plants. Possesses antibacterial, insecticidal properties.

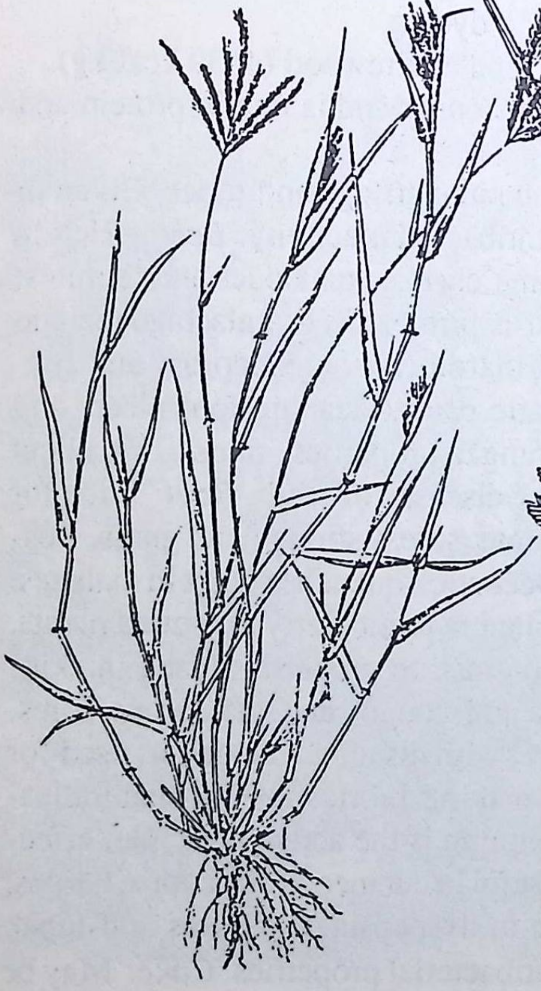
DESMOSTACHYA Stapf (*Poaceae*)

Monotypic, tufted perennial grass; Africa and India.

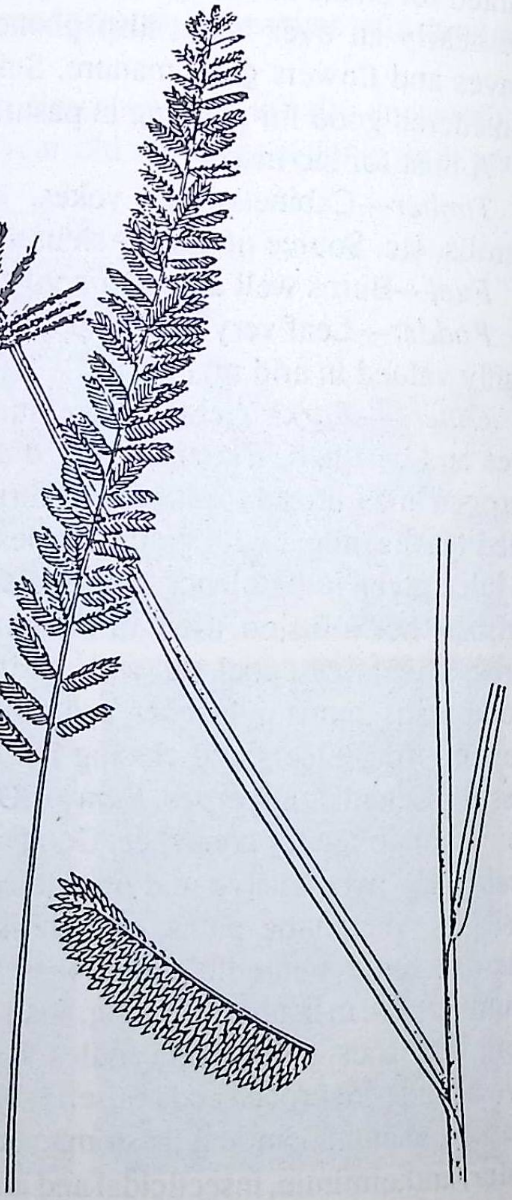
D. bipinnata Stapf syn. *Eragrostis cynosuroides* Beauv.

Beng & Sans–*Darbha, kusha;* Hindi–*Dab, durva;* Tel–*Kushadarbha, darbha.*

Habit—A tall, tufted, perennial grass, wih stout stolons, covered with



Dichanthium annulatum



Desmostachya bipinnata

shiny sheath, 30–150 cm. *Stem*—creeping, much-branched, tufted, smooth, profusely rooted. *Leaf*—linear to linear-lanceolate, acuminate, scabrid on margins. *Inflorescence*—erect, strict, pyramidal, 20–30-flowered panicle, floral glumes 16–20 mm long, ovate, acute. *Spikelet*—sessile, crowded, 2-seriate, pale brown; during rains. *Seed*— obliquely ovoid, laterally compressed; 0.5–0.6 mm long, August–October.

Distribution and Ecology—Throughout the plains at dry places. Flourishes well in dry and hot situations, forming big tussocks in sandy-desert areas; and with a rainfalll of 150–300 mm and on wastelands and fields; also on saline and alkaline soils, in low-lying or waterlogged sites.

UTILIZATION

Reclamation—Excellent sand-binder in deserts; can be grown on soils mentioned above.

Fodder—Good fodder (crude protien, 6.75%) in arid zone; can be mixed with gram and wheat as fodder; though not liked by other cattle, buffaloes eat it when tender; can also be used in mixtures.

Others—*Culm:* Used for thatching and rope-making and brooms. Pulp (35%) suitable for paper. Diuretic; used in urino-genital troubles, and also in dysentery.

DICHANTHIUM Willem. (*Poaceae*)

Perennial or annual grasses; tropics; 8 spp in India.

D. annulatum Stapf syn. *Andropogon annulatum* Forssk. MARVEL-GRASS

Beng–*Loari.*

Bombay–*Lahan marvel, zinzoo;* Punjab–*Palven, minyar;* Uttar Pradesh–*Jaunera, palmaha.*

Habit—An erect to procumbent, densely tufted, xerophytic perennial. *Stem*—creeping, rhizomatous. *Culm*—erect, up to 1.2 m, abruptly ascending from the rhizome, smooth, purplish-red, purplish, or bluish, bearded at nodes. *Leaf*—glabrous or hirsute, with tubercled hairs on the upper surface, somewhat waxy, 7.5–45.0 cm × 3.6 mm. *Inflorescence*—several subdigitately arranged racemes, attached at the apex of axis, 2.5–7.0 cm long, usually purplish. *Spikelet*—2 in each spike.

Distribution and Ecology—Common throughout the plains and hills of India, up to 910 m. Adapted to a wide range of climate and soil, often found in hedges, roadsides, lawns and pastures; thrives well on well-drained soils in sheltered situations. Also found on deep black clay, sandy loam, sandy, rocky, semi-rocky soil, sandstone and loamy soil subjected to waterlogging, alluvial, saline and highly alkaline, arid ravines but does not thrive on acidic soils. Also found on hillslopes and wastelands and mineral soils. Drought-resistant.

CULTIVATION/REGENERATION

Artificial Regeneration—Seed is produced in large quantity but germination poor; rooted slips or springs can also be employed; planting can be done at 60 cm apart during rains. For transplanting the nursery seedlings, a rainy day is preferable.

UTILIZATION

Reclamation—Can be grown on the soils mentioned above for reclamation, particularly saline, alkaline, semi-rocky, arid and semi-arid soils and sand-dunes, and other wastelands. Highly promising for pasture and reseeding degraded grasslands. Forms open turf under grazing.

Fodder—Esteemed and highly palatable wild grass (crude protein, 2.7–8.1%); eagerly eaten when young and also during flowering. Can be converted into hay, particularly before flowering (crude protein, 5.2%).

D. aristatum (Poir.) C.E. Hubbard syn. *D. nodosum* Willem.; *Andropogon nodosum* (Willem.) Nash is a tufted, decumbent, branching perennial, spreading through long runners, with narrow leaves and many-jointed racemose inflorescence, found in the plains of Central and South India. Highly salt-tolerant and palatable grass. Though needs water, withstands drought. Forms pastures.

D. armatum (Hook.f.) Blatter & McCann syn. *Andropogon armatus* Hook. f. is an erect, tufted, branched grass, found in Konkan region; suitable for reclaiming rather hard and stony soils on exposed hilltops.

D. bladhii Clayton syn. *Bothriochloa bladhii* (Retz.) S.T. Blake; *B. glabra* (Roxb.) A. Camus; *B. intermedia* (R.Br.) A Camus; *D. glabrum* (Roxb.) Jain & Deshpande is a tufted, perennial grass, up to 1.5 m, found in Kashmir, Punjab, Bihar and Tamil Nadu. Suitable for the reclamation of gullies and ravines. An excellent-fodder.

D. caricosum A.Camus syn. *Andropogon caricosus* Linn. (Beng–*Detara;* Kan–*Urukunhullu;* Bombay–*Marvel;* Uttar Pradesh–*Kartah, kheral*) is a tufted, erect, perennial, 30–60 cm, with 3.5–12 cm long leaves, found almost throughout the plains and on hills, up to 910 m. Prefers dry, sandy habitat; also flourishes on bunds in sheltered situations; withstands considerable drought. Valuable as pasture (crude protein, 7.58%), and hay as *D. annulatum;* cattle relish it. Forms turf when grazed.

D. insculpta Clayton syn. *B. insculpta* (Hochst. ex A. Rich.) A. Camus is a grass, found on the Nilgiri and Palni hills. Suitable for soil-conservation. Used as a fodder .

D. ischaemum Roberty syn. *B. ischaemum* (Linn.) Keng is an erect, tufted perennial, up to 1m, with mostly basal leaves and purple spikelets, found in North-West Himalayas, up to 4000 m. Used as a fodder. suitable for reclamation of rocky hillsides, gravelly beds of mountains with sparse rainfall, and gullies and ravines.

D. parviflorum (R.Br.) de Wet syn. *Capillipedium parviflorum* (R.Br.) Stapf; *Andropogon micranthus* Kunth is a semi-tall perennial grass, up to 1 m, found on North and East Himalayas at 1000–2000 m and in Chota Nagpur and on the Nilgiris; found in alpine pastures, grasslands and waste places; also found on the Konkan coast and the Deccan hills. Suitable for the reclamation of saline and alkaline soils. Eaten by sheep, cattle and goats.

D. pertusus Clayton syn. *B. pertusa* (Linn) A. Camus (Beng–*Kada chandi ghas*) is a stoloniferous, sward-forming perennial grass, with culms up to 60 cm, sometimes creeping and rooting at the nodes and linear leaves and purple spikes, found in Kashmir, eastern India and Tamil Nadu in open grasslands. Withstands moderate periods of drought, grazing and trampling. Suitable for the reclamation of ravines, sandstone, rocky, gravelly soils and rangelands. Highly valued for fodder; can also be converted into hay.

DICHROSTACHYS (A. DC.) Wight & Arn. (*Mimosaceae*)

Shrubs and small trees; Africa to Australia; 2 spp in India.

***D. cinerea** (Linn.) Wight & Arn. syn. *D. glomerata* (Forssk.) Chiov.; *D, nutans* (Pers.) Benth.

Hindi–*Vurtuli;* Kan–*Odatare;* Mar–*Segumkati;* Tam–*Vidattalai;* Tel–*Veltura.*

Habit—A thorny, fast-growing, small tree, with branchlets terminating into thorns. *Leaf*—bipinnate: pinnules minute, 12–25 pairs, 1–10 mm × 0.3–4.0 mm, linear. *Flower*—in two colours, yellow and natural pink, in axillary or extra-axillary, cylindrical, peduncled spikes. *Fruit*—glabrous, flat, subarticulated, dark-brown pod, twisted when ripe, 6–10-seeded; August–November. *Seed*—deep brown, glossy, 4–6 m × 3.0–4.5 mm.

Distribution and Ecology—North-western, central and southern India from Punjab and Rajasthan to Karnataka. Cultivated in arid areas. Found on deep sandy, and loamy soils, with 25–400 mm rain; also found in dry scrub-

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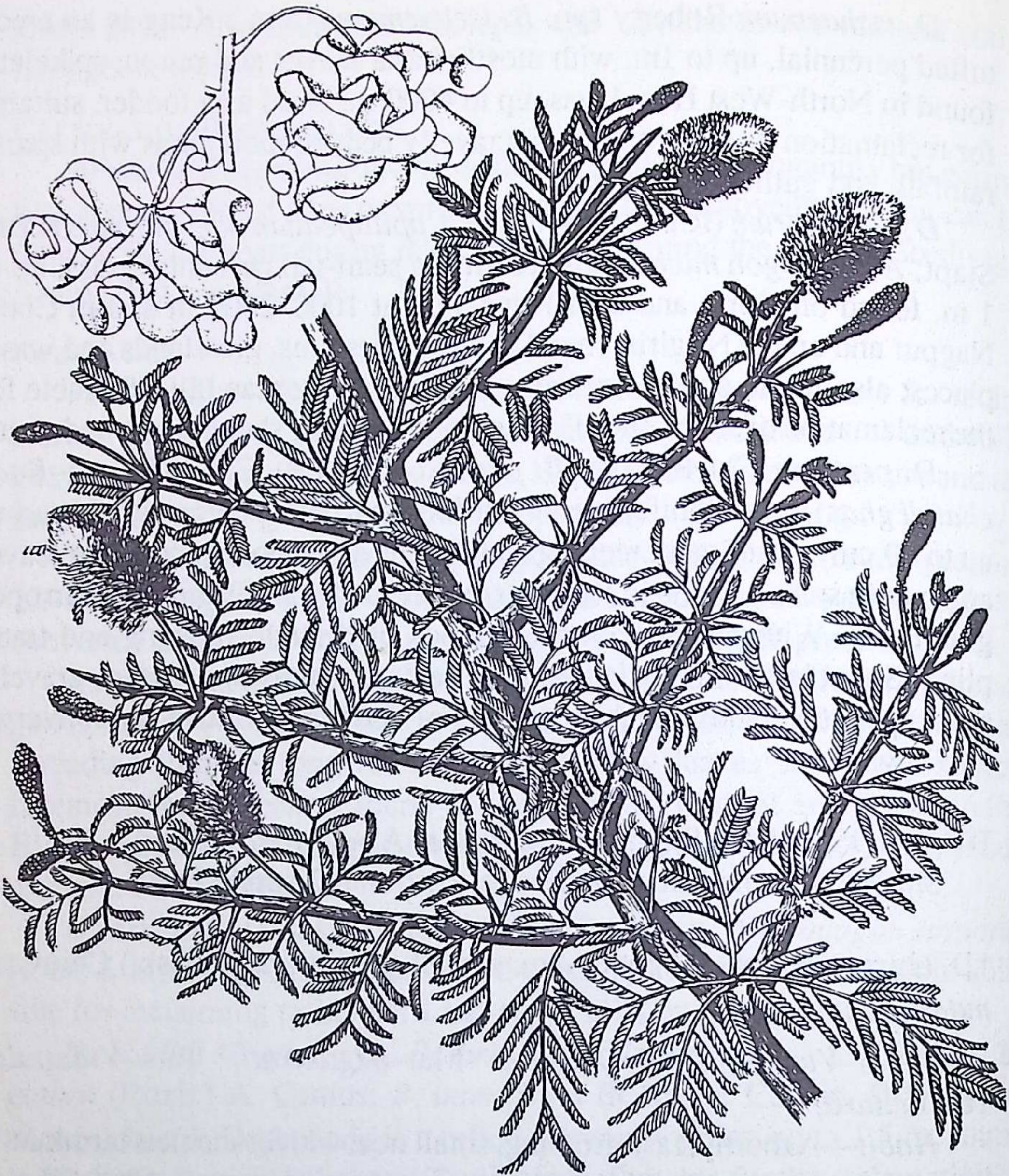
*1 Probably two provinences of this plant have recently been introduced from Israel under the names *D. glomerata* and *D. nutans*.



Dichrostachys cinerea

forests and on sandstone, rocky, refractory sites, and shifting sand-dunes.Forms understorey of the dry-deciduous, low forest. Also found in ravines. Drought- and frost-resistant.

Cultivation/Regeneration—From seeds.

UTILIZATION

Reclamation—Fast-growing, extreme resistance to drought and frost, and rapid suckering and its great capacity for regeneration hold great promise in afforestation. Well-adapted for arid and dry regions as a cover-plant; holds good promise in stabilizing shifting sand-dunes and reclamation of shallow, sandy loam, deep sandy soils, semi-rocky or rocky and refractory sites, land-slides and gullies and ravines. Valued as a cover-plant. Fixes nitrogen.

Timber—Walking-sticks; tentpegs.

Fuel—A very good fuelwood.

Fodder—Leaf highly nutritive (crude protein, 15.3%). Can be used as fodder and as green manure.

Others—*Tender shoots:* Bruised and applied in eye-troubles. *Root:* Astringent; used in rheumatism, urinary stones and renal troubles.

DIPLACHNE Beauv. (*Poaceae*)

Tall, tufted, perennial grasses; tropical regions; 1 sp in India.

***D. fusca** (Linn.) Beauv. ex Roem. & Schult. KARNAL- OR KALLAR-GRASS

Tam—*Mandipillu.*

Bombay—*Shotigander;* Haryana–*Dhaner.*

Habit—A tall, erect, tufted, aquatic or semi-aquatic, rhizomatous perennial. *Culm*—60–150 cm, rooting and branching from lower nodes. *Leaf*—linear, smooth, flat or convolute, with filiform tips, 25–55 cm × up to 5 mm. *Inflorescence*—racemes, 10–40 cm. *Spikelet*—4–13-flowered, grey-green or olive-green. *Fruit*—dorsiventrally flattened, ovoid-oblong caryopsis; dispersed through wind.

Distribution and Ecology—Met with in the upper Gangetic plains, West Bengal, Orissa, Andhra Pradesh, Tamil Nadu and Kerala, up to low elevation. Native grass of alkaline lands, widespread on depressions and low-lying and waterlogged and saline sites.

Cultivation/Regeneration—Seed easily spreads through wind. Can also be planted at any time from March to August. Propogation through rooted slips or stem-cuttings is preferred to seed; irrigation essential immediately after planting. In the first year, 2–3 cuts and 5–8 cuts during second and third year can be obtained. Yields of 30–40-tonne green forage per hectare can be obtained on highly alkaline soils, but higher during rains. Should preferably be resown after three years.

UTILIZATION

Reclamation—Extremely suitable for reclaiming saline and alkaline and waterlogged soils. Improves physical and chemical properties of soils. Suitable for growing on fallow-lands of Haryana, Punjab and Uttar Pradesh;

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*Some treat it as *Leptochloa fusca* (Linn.) Kunth.

can also be grown alone for grazing or in association with alkaline-tolerant trees for afforestation. Withstands grazing.

Reported to be associated with nitrogen-fixing bacteria.

Fodder—Succulent leaves palatable and used as fodder (crude protein, 8.5%); reported to increase milk and maintain salt-balances in salt-affected areas. Yields more forage on alkaline than on normal soil. Growing the grass beyond three years reduces the yield and nutritive value.

Fuel—Yields methane comparable to natural gas. Ethanol also may be produced.

Others—Grass: A possible source for paperpulp. Can be used as a substitute for growing oyester-mushrooms.

DODONAEA Mill. (*Sapindaceae*)

Shrubs, rarely trees; tropics and subtropics, especially Australia; 1 sp in India.

D. viscosa (Linn.) Jacq.

Hindi–*Sinatha;* Kan–*Bundara, bundurgi;* Mal–*Unnatarauvi;* Mar–*Lutchmi;* Oriya–*Mohra;* Tam–*Viraaly, velari;* Tel–*Bandedu.*

Bihar–*Mehndi;* Bombay–*Jakhmi;* Punjab–*Sanalta, benmmeu.*

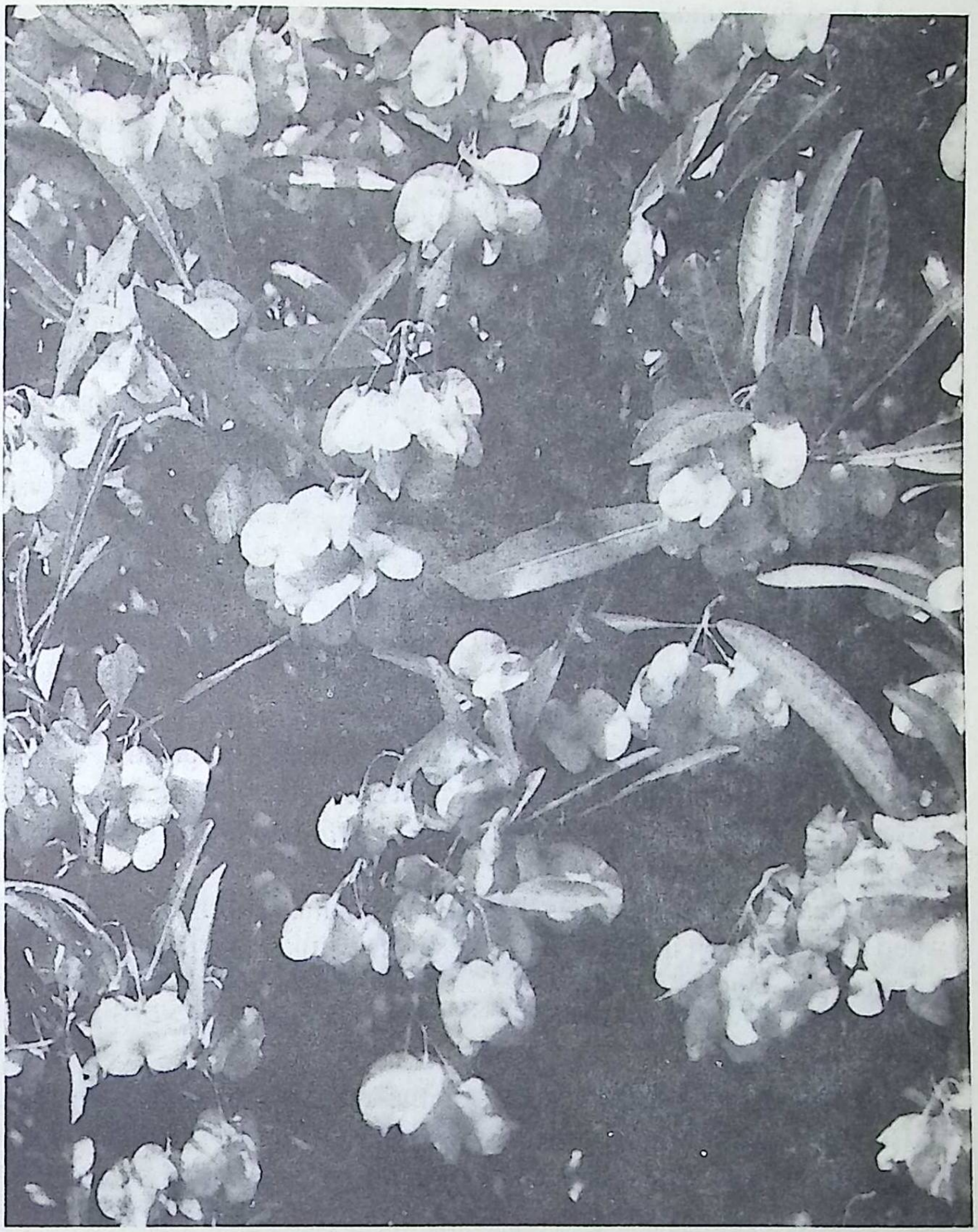
Habit—A gregarious, evergreen shrub or tree. *Stem*—terete or somewhat angular with twiggy branches; young shoots viscid with a yellow resin. *Leaf*—oblanceolate, elliptic-oblong or obovate, 8 cm × 1.8 cm, covered with shining yellow-resin, coriaceous, rough, 3–10 cm × 6–37 mm. *Flower*—small, greenish-yellow, in large numbers, in short, axillary, spreading cymes. *Fruit*—membranous, compressed, 1.5–1.8 cm long, numerous greenish or brown, 2–3-winged capsule; cold and early hot season. *Seed*—nearly globose with slight flattening, black, 3 mm; 70,000–100,000/kg; August–September; germination 30–70%.

Distribution and Ecology—Throughout India, flourishing from the seacoast to the Himalayas, up to 2500 m, as an undergrowth to *Pinus roxburghii* . Also, commonly found in drier and hot regions of South India. Grows on sandy shores, *kankar* soils, rocky soils and red gravelly and sandy soils. Very commonly grown as an ornamental hedge.

Silvicultural Characters—Does not usually coppice; very sensitive to fire because of resin.

CULTIVATION/REGENERATION

Natural Regeneration—Profusely regenerates from seed; and this together with its capacity to grow on poor, dry soils and immunity from grazing permits its wide-spreading and abundance.



Dodonaea viscosa

UTILIZATION

Reclamation—A good soil-binder, very useful for reclothing denuded tracts and slopes and to afforest the soils mentioned above; useful for reclaiming gullies and ravines, marshy lands and mine-wastes of copper. Recommended for shelterbelts and hedges for controlling sand-drift areas and for social forestry.

A host for *Santalum album.*

Timber—Tool-handles, walking-sticks, turnery, and engraving.

Fuel—A good firewood (sapwood, 5035 kcal; heartwood, 4939 kcal/kg).

Others—Bark: Used in astringent bath and fomentation. Yields tannins (5.8%). *Leaf:* Employed as manure. Utilized for treating wounds, swellings, burns and rheumatic pains. Chewed as a stimulant and used as an adulterant to Cola in Peru. Possesses anthelmintic and antibacterial properties and acts as protectant from pulse-beetle. Yields tannins (18%), and essential oil. *Fruit:* Substituted for hops (*Humulus lupulus* Linn.). *Seed:* Reported to be edible; yields a semi-drying oil (18.6%). Extract exhibits anti-fungal properties.

ECHINOCHLOA Beauv. (*Poaceae*)

Annual or perennial grasses; warm regions; 7 spp in India.

E. colona Link syn. *Panicum colonum* Linn. JUNGLE-RICE

Beng–*Shama;* Hindi–*Sawank;* Tam–*Karumpillu, varsanumpillu;* Tel–*Kaprodagaddi, othagaddi.*

Bombay–*Borur, pachushama;* Punjab–*Sawuk.*

Habit—A slender, tufted, quick-growing annual, up to 1m. *Leaf*—flat, glabrous, 5–20 cm × 4–11 mm. *Inflorescence*—simple racemes, rather distant. *Spikelet*—ovoid or ovate-elliptic, 2.5–3.2 mm long. *Fruit*—broadly elliptic, plano-convex.

Distribution and Ecology—Throughout India, up to 1800 m. Common weed of cultivation in rich soils, waterlogged situations, paddy-fields and irrigated dry lands.

UTILIZATION

Reclamation—Recommended for the reclamation of marshy lands and rangelands.

Fodder—Valued as fodder and relished by cattle at all stages; cattle said to fatten and become healthy. Can be converted into hay and stacked for 5–6 years.

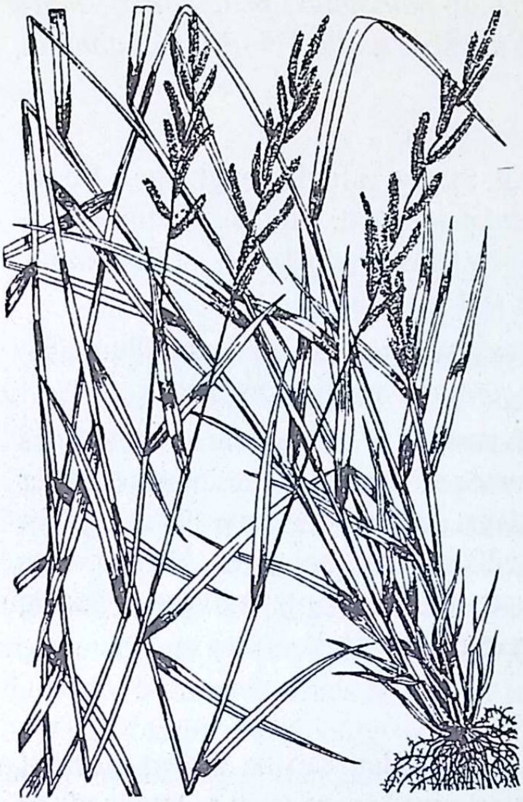
Others—Shoot: Young shoots eaten in Java. *Seed:* Eaten during scarcity.

E. crusgalli Beauv. syn. *Panicum crusgalli* Linn. BARNYARD-MILLET

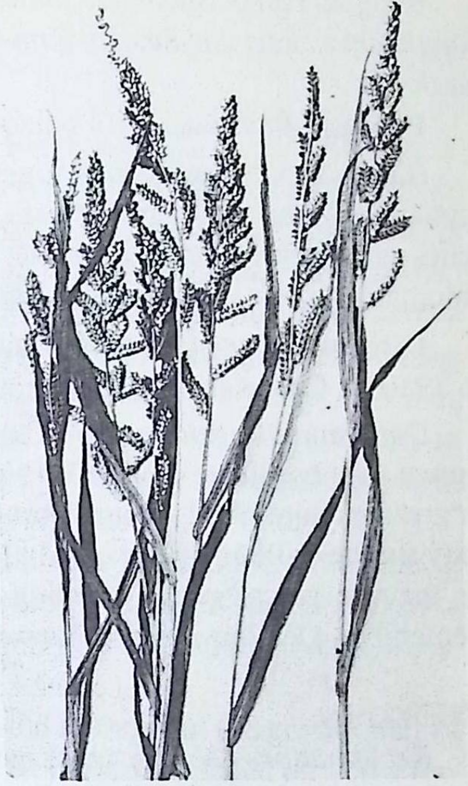
Beng–*Burashama;* Guj–*Addansamo;* Hindi–*Samak;* Mar–*Sama;* Tam–*Oothuphul;* Tel–*Peddaodllu.*

Bombay–*Banti, sarvant;* Punjab–*Barasanwak.*

Habit—A tufted annual, up to 1.2 m. *Leaf*—linear, flat, 7.5–52.0 cm.



Echinochloa colona



E. crusgalli

Inflorescence—usually more or less branched, 2.0–5.0 cm long. *Spikelet*—3.5–4.8 mm, awn present. *Fruit*—ovoid caryopsis.

Distribution and Ecology—Throughout India, up to 1800 m; sometimes cultivated for fodder. Common weed in paddy-fields; grows on light soils.

Cultivation/Regeneration—Best time for growing in North Gujarat is during February–April; ready for cutting in 45–90 days.

UTILIZATION

Reclamation—Grown for reclamation of saline and alkaline soils in Egypt.

Fodder—Good green fodder for cattle (crude protein, 6.2%); suitable for ensilage and not for hay.

Others—*Seed:* Eaten during scarcity; reported to be used as adulterant to fennel.

E. frumentacea Link syn. *Panicum frumentaceum* Roxb. JAPANESE BARNYARD-MILLET

Beng & Hindi–*Shamula, sanwa;* Guj–*Samoghas;* Kan–*Samai;* Mar–*Janglisama;* Sans–*Shyamaka;* Tam–*Kudraivalipillu;* Tel–*Bontachaamalu, paalodllu.*

Bombay–*Bavto sawan;* Punjab–*Sawank.*

Habit—A very quick-growing, tall, robust, tufted annual, up to 1.5 m. *Leaf*—broad, up to 20 cm. *Inflorescence*—distant, simple raceme, sometimes with dense corymbose panicle. *Spikelet*—large. *Fruit*—small, smooth, shining caryopsis, with rounded base and sharp apex.

Distribution and Ecology—Cultivated over the greater part of India, up to 1950 m. Grows on soils of Punjab, Gujarat and the Deccan.

Cultivation/Regeneration—Cultivated as a rainfed crop; sometimes grown as subordinate crop to *Sorghum* or maize and sometimes as fodder or green manure. Seed is usually broadcast during June–July; (9–11 kg/ha); may also be drilled (7–8-kg seed/ha) at 30 cm asunder in lines. No irrigation or manure given; needs weeding and interculturing; harvested during September–October. Two smuts were recorded on it.

UTILIZATION

Reclamation—A very quick-growing millet; can be grown on light sandy soils under fair rainfall or in waterlogged areas, such as low lands or bunds of rivers which often submerg and on rough rangelands. Grown to reclaim lands too saline for other crops in Egypt.

Fodder—Fed green or as silage or hay (protein, 10.9%); highly relished by livestock. Seed given as a feed to canary.

Others—Plant: Considered cooling, stomachic and useful in biliousness and constipation. *Seed:* Grain consumed either cooked in water or milk and sugar or parched (crude protein, 6.2%); rich in lysine, cystine and histidine with better nutritive value than polished rice; contains vitamin-B; bran contains glutelin and albumin. Sometimes mixed with rice and fermented for a beer.

E. stagnina Beauv. syn. *Panicum stagninum* Retz.; Hook. f. (Fl Br Ind) in part (Beng–*Dul;* Kan–*Kaadudabhaihullu;* Tel–*Bonthaodllu;* Bombay–*Banti*) is a perennial or annual grass, 90–120 cm high, with soft, succulent stem and linear leaves, found throughout India, partly submerged in stagnant pools and marshes, on the banks of lakes and tanks and in cultivated fields and can be grown for reclaiming wetlands. Considered a rich fodder, both green and hay. Stem rich in sugars (sucrose, 10%; reducing-sugars, 7%) and may give molasses useful for beer or vinegar; also used for thatching. Grain eaten during scarcity.

*EMBLICA Gaertn. (*Euphorbiaceae*)

Undershrubs or trees; chiefly in tropical and subtropical regions; 2 spp in India.

E. officinalis Gaertn. syn. *Phyllanthus emblica* Linn. THE INDIAN GOOSEBERRY, EMBLIC MYROBALAN

Beng & Hindi–*Amla;* Guj–*Amali, aonla;* Kan–*Amalaka, nelli;* Mal & Tam–*Nelli;* Mar–*Awala;* Sans–*Amalaka;* Tel–*Amalakamu, raatausirika.*

Habit—A small or medium-sized, deciduous tree, 15 m/2.1 m. *Bark*—fairly smooth, pale pinkish- or greenish-brown or greenish-grey, exfoliating into thin flakes. *Leaf*—feathery; small, narrowly oblong, 8–12 mm × 2–3 mm, distichous, appearing like a pinnate leaf. *Flower*—small, yellowish in dense, axillary fascicles on branches below leaves: male several, with slender pedicels; females few; June–July, also in February. *Fruit*—depressed globose, fleshy up to 4 cm diam, with 6, faint,longitudinal lines; endocarp bony, 3 triangular cocci, 6-seeded; December–January. *Seed*—trigonous blackish-brown; 68,000–89,000/kg; germination 30 days, 40%; viable for 6 months; needs hot-water treatment.

Distribution and Ecology—Found wild throughout the greater part of India; often cultivated in gardens and homeyards. Cultivated only in a few districts of Uttar Pradesh and Madhya Pradesh. A hardy crop, grows in variable soil conditions; sensitive to frost and drought. Higher humidity favours luxuriant growth.

Cultivation/Regeneration—Usually propagated from seeds and also vegetatively through inarching and budding. Being a highly cross-pollinated crop, seed-raised trees have prolonged juvenility and wide variability in productivity. Fresh seed is sown during February–June. Budding gives successful results. In saline/sodic soils, the hard pan must be broken by deep-digging;5–15-kg gypsum/pyrite, 4060-kg farmyard- manure and 15–20-kg riversand should be added to pits. Intercropping with tomatoes, brinjal, cauliflower, onion, cowpea, blackgram, pea, etc. is possible.

UTILIZATION

Reclamation—Can successfully be grown in salt-affected soils; particularly soils from slightly acidic to saline/sodic (*p*H 6.5–9.5). Suitable for reclaiming bauxite-mined and dry areas; also recommended for agro- and social foresty.

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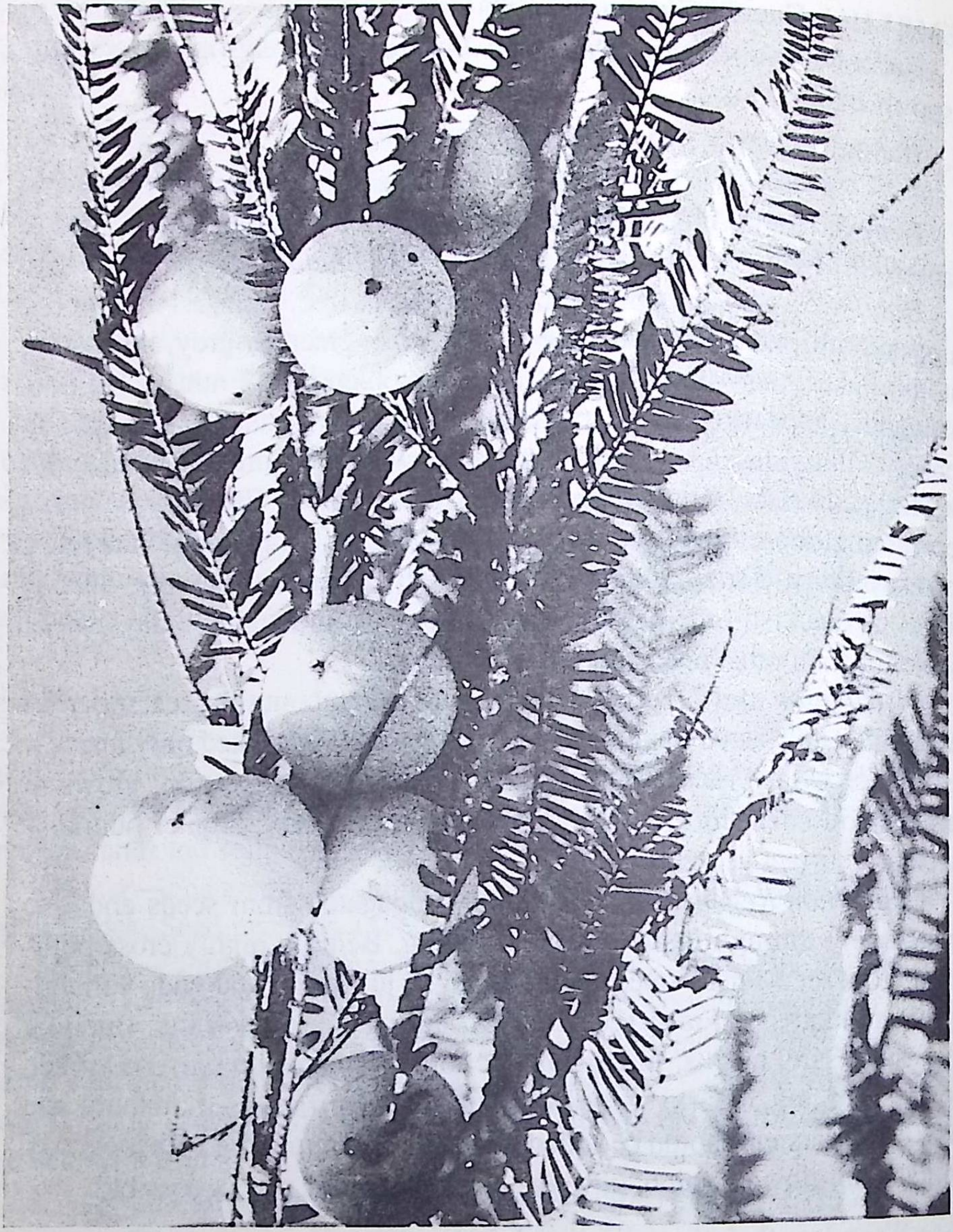
*Some merge it with *Phyllanthus* Linn.



Emblica officinalis

Timber—Agricultural implements, poles; inferior building, and furniture work. Mixed with hardwood, suitable for Braille-printing paper.

Fuel—Yields firewood and charcoal.

Fodder—Leaf and fruit given as fodder.

Others—Bark, Leaf & Fruit: Rich in tannins. Fruit tannins are used in mixtures for sole-leather. *Leaf:* Eaten raw. Source of medicinally important compound, rutin. *Fruit:* Eaten raw and much esteemed for making pickles, preserve, etc. Acrid, cooling, refrigerant, diuretic and laxative. Probably the richest-known natural source of vitamin-C, containing 20 times more than orange-juice. A tannin, containing gallic acid, ellagic acid and glucose and naturally present in the fruit, prevents or retards the oxidation of the vitamin and renders it a valuable antiscorbutic in the fresh as well as in the dry condition. Helps in the recovery of tuberculosis patients. Fruit is an important constituent of serveral vegetable drugs: CHYAVANPRASA, an ayurvedic tonic; SEPTELIN, useful in chronic infection of ear, nose and throat, and in burn; LUKOL, for I.U.D, leucorrhoea and bleeding; TRIPHALA, for enlarged liver, stomach ailments, piles, and as laxative; and BONNISON, for gastrointestinal disorders in infants. Fruit also used in antivomiting syrup and in composition for the treatment of dental and periodontal diseases; and as restorative tonic in diabetes. Several other medicinal properties have also be attributed. Dried fruit is detergent and used as shampoo. *Seed:* Used in asthma, bronchitis and biliousness.

EUCALYPTUS L'Hérit. (*Myrtaceae*)

Evergreen, aromatic trees or sometimes shrubs, variously known as AUSTRALIAN GUM, BLOODWOOD, BLUEGUM, EUCALYPT, GUMTREE, IRONBARK, STRINGYBARK, BOX, MALLEE, etc., characteristic to Australia and Tasmania, extending North to New Guinea, the Philippine Islands, Timor and Java, introduced the world over in more than 80 countries. About 115 spp mostly tall, straight- and clear-boled trees, introduced into India.

Some species reach enormous size near the coasts and on mountains and some are dwarf or stunted shrubs, mainly growing in the sandy deserts of Australia. *Bark*—Varies much, usually bluish-white, persistent or deciduous; easily recognized aiding in the classification. *Leaf*—simple, entire, gland-dotted, and horizontal, opposite and sessile in the juvenile condition. *Flower*—white, rarely yellowish or some shade of red, usually in axillary umbels or heads, sometimes corymbose or paniculate; calyx-lobes and petals united, forming variously shaped deciduous budcap (operculum or calyptra), stamens many, in some species highly ornamental and sweet-smelling. *Fruit*—capsule, sometimes hard and woody, wholly or partially included in the calyx-tube. *Seed*—numerous, small; 75,000–100,000/kg in *E. tereticornis*; germination 5–15 days; viable up to 2 years; collected from choice-trees, air-dried and stored in air-tight containers.

EUCALYPTUS

Eucalyptus was introduced into India around 1790, mainly for ornament on the Nandi hills near Bangalore. Regular trials were started in 1843 when Bluegum (*E. globulus*) was successfully introduced on the Nilgiri hills. Since 1911, several other species have been introduced at various places in the country (Table 1 & 2). The species range from those which produce large amounts of fuelwood under saline or periodically waterlogged conditions, to multi-stemmed, resilient mallees which tolerate burning, browsing and drought, and to remarkably productive forest-trees responsive to fertile, moist conditions. *E. tereticornis* has extensively been cultivated, as it yields high return, and large-scale plantations were raised in Karnataka in 1952, and in other parts from 1962. Because of rapid growth (3–5m/year), ability to grow on several kinds of soils and in various climates along with great utility and high economic return, and the general resistance to grazing, eucalypts have been planted to replace low-value

Eucalyptus sp.

natural scrub-forest for afforesting arid and semi-arid areas and along highways, canal-banks and railway-lines. Large tracts of forests, farms and degraded lands in Karnataka, Gujarat, Uttar Pradesh, Punjab and Haryana have soon been brought under eucalypts. The MYSORE GUM plantations (*Eucalyptus* Hybrids) covered an area of about 988,000 ha in India in 1983, and now form one of the most important industrial timbers.

Ecology—Many *Eucalyptus* spp are versatile, adapted to various climatic, edaphic and ecological conditions and usually do well from the sealevel up to 1000 m. Some prefer hot and arid climate, a few arid and cold deserts and snow-line and some flourish in very moist areas. Hence, *Eucalyptus* spp are extensively cultivated in the subtropical and warm-temperate regions including arid tracts where temperature ranges from below 0°on the hills to 47°C; they grow in areas with a rainfall from 500 to 1500 mm. Eucalypts grow on from the poorest sandy to the richest of loams and adapt to different soil-stresses and grow well in well-drained soils. They not only rapidly grow in marhsy areas but grow well in arid and semi-arid soils.

Silvicultural Characters—Eucalypts are light-demanders. They usually have a spreading rootsystem and are generally wind-firm. Young plants need protection from frost for 1–2 years. Young trees and species with thin or deciduous bark are susceptible to fire, though older trees, particularly with persistent bark, are but little affected; most species have good power of recovery. Many species coppice well. They are not browsed by goats.

CULTIVATION/REGENERATION

Natural Regeneration—Eucalypts reproduce from seed, and a limited regeneration occurs on fresh soils, such as embankments and fallow-fields, and on the Nilgiri and Shimla hills.

Artificial Regeneation—Transplanting the nursery-raised seedlings was adopted for plantations in India. Planting the seedlings and stump-planting have met with varying success. Direct sowings are rare. Seed is sown during February–March in beds, composed of loam and decayed manure, 10.2–12.5 cm deep or in flat boxes. Normally, 4–6-week-old, 5–10 cm high seedlings are pricked out 5.0–7.5 cm apart, and for naked-root plants pricked out at 10 cm asunder, with protection from the mid-day sun till established. Irrigation should be controlled. Seedlings are transplanted in baskets, bamboo-tubes or polythene-bags, which are later established in pits when 30 cm high. The time taken till transplanting varies with the species and elevation; hence, the nursery-sowings are suitably adjusted to coincide with rains.

Plantations and Tending—Generally planted pure in single or multiple rows or in blocks for various objectives. A spacing of 2.4–3.6 m × 2.4–3.6 m is adopted on good soils for vigorous species for clear boles; closer spacing is given on poor soils for slow-growing species which tend to branch low. Weeding and working of soil once a month during the first few years are necessary. Crop is thinned between sixth and tenth year.

Management—Rotated at the age of from 8 to 14 years, and clear-felled at the end of each rotation and regenerated through coppicing. However, a rotation of more than 12 years is not advisable for pulp, as the wood develops dark colour which affects the strength of pulp. Plantations under intensive management can be harvested as early as 4 to 5 years. For firewood and charcoal, 12-year rotation is recommended and thereafter for small wood. Under favourable conditions, the coppice-crops (90% stumps) can be taken, after which the area needs to be replanted.

Diseases—Rootrot, caused by *Ganoderma lucidum*, spreads from infected woody debris in the soil; such trees are wind-thrown. They should be isolated by trenching or interplanting with resistant species. In South India, *Corticum salmonicolor* causes a stem-disease characterized by pink-staining. Young plants repeatedly die back and may be killed, whereas older ones develop cankers and gummosis.

Pests—Termites are a major hazard to Mysore gum plantations in dry regions and on sandy soils. Mixing 0.1g of persistent chlorinated hydrocarbon insecticide in every 30 cm^3 pit gives effective protection for five years. *Celosterna scabrator* is a potentially dangerous borer to younger plantations; older plants are, however, resistant.

Yield—Tough fast-growing, the growth widely varies with the soil and management. An average plantation of *E. tereticornis* yields wood *c* 3t/ha/year; on poor sites yield is much less (*c* 0.6t/ha/year). In semi-arid, non-irrigated conditions of Gujarat, with a spacing of 1.3m × 1.3m, a biomass (wood, bark, branches) of 5 t/ha was obtained at 12 months and 66.5 t/ha at 36 months; the utilizable biomass was *c* 2.25t/ha and 43.5 t/ha, respectively. The wood sharply increases between 18 and 24 months.

UTILIZATION

Reclamation—*Eucalyptus* spp have continuously been planted for afforestation of various types of soils under a variety of climates. These are planted in arid and semi-arid areas, waterlogged areas, cold deserts, on river- and canalbanks, bared hillsides, ravines, railway-lines and other degraded soils, such as saline and alkaline soils, skeletal, sodic, laterite soils, shallow soils, sand-dunes and saline sandy beaches; a few, such as *E.*

globulus, which possess dense rootsystem and drop abundant leaf-litter, have been recommended for soil-binding. Certain species, such as *E. calophylla*, *E. camaldulensis*, *E. grandis*, *E. rudis* and *E. saligna*, absorb abnormal quantities of water and planted to reclaim the waterlogged areas; also recommended as antimalarial measure in marshy areas. A few are also planted for ornament. *E. brachypoda*, *E. camaldulensis*, *E. citriodora*, *E.microtheca*, etc. grow under arid conditions, and on soils which are skeletal and ravinous. *E. camaldulensis*, *E. melanophloia*, *E.terminalis*, *E. tessellaris*, etc. can establish on sandy soils. The 'Hybrid' (*E. tereticornis*), *E. melanophloia* and *E. rudis* are successful in sandy, saline, alkaline and arid tracts of Punjab; *E. crebra*, *E. gomphocephala*, *E. goniocalyx*, *E. microtheca*, *E. occidentalis*, *E. odorata*, *E. populnea*. *E. robusta*, *E. saligna*, *E. tereticornis*, etc. also tolerate saline and alkaline conditions and colonize such areas. Some species tried on saline and alkaline soils of Uttar Pradesh, Haryana, Tamil Nadu and other States have shown that they can yield more biomass than other indigenous species; several species have successfully been grown for reclamation of the alkaline soils (*p*H 8.5–10.5) in Banthra of Uttar Pradesh. Trials of *Eucalyptus* 'Hybrid' revealed that *usar* (alkaline) soils with good drainage and *p*H up to 8.5 can be reclaimed by planting in pits. Soils with a *p*H of 8–11, usually associated with poor drainage and a *kankar* pan, can be afforested by planting in deep pits filled with other soils. The 'Hybrid' has been reported to grow better with the addition of gypsum or farmyard-manure as amendments to soil. In general, *E. camaldulensis*, *E. melanophloia* and *E. terminalis* are promising. On calcareous soils, *E. tessellaris* is also promising.

Several species have also been introduced to reclaim vast areas of dry, cold deserts in the Himachal Pradesh and Jammu & Kashmir, and to provide fuel and timber. Some important introductions are: *E. aggregata*, *E. bridgesiana*, *E. cineria*, *E. coccifera*, *E. dalrympleana*, *E. delegatensis*, *E. gunnii*, *E. johnstonii*, *E. niphophila*, *E. ovata*, *E. parviflora*, *E. racemosa*, *E. robusta* and *E. vernicosa*. Besides these species, *E. acmenioides*, *E. bicolor*, *E. ficifolia*, *E. globulus*, *E. goniocalyx*, *E. longifolia*, *E. macror(r)hyncha*, *E. maidenii*, *E. melliodora*, *E. microcarpa*, *E. microcorys*, *E. obliqua*, *E. pilularis*, *E. regnans*, *E. resinifera*, *E. rudis*, *E. saligna*, *E. sideroxylon*, *E. tereticornis* and *E. viminalis* are other species grown on the Nilgiri and Shimla hills. Eucalypts have also been planted on barren hillsides in India. *E. grandis* is promising for afforestation of difficult sites, eroded areas and deep slopes. *E. camaldulensis* and *E. tereticornis* successfully grow on sites disturbed by mining, whereas *E. microtheca* and *E. robusta* can revegetate mine-spoil heaps. They may be useful for reducing eutrophication as they absorb large quantities of nitrogen. These are not browsed by goats.

Timber—An important hardwood-yielding genus, principally in Australia. Some species possess the hardest, heaviest and the most durable wood. The wood from *E. marginata* is fire-resistant and reported to be used for chimneys in Western Australia. In India, the species are mainly exploited for fuel (*E. globulus*), and also for timber; essential oil is a byproduct. These timbers are employed for transmission poles, packing-cases, crates, boxes, beams, columns, poles and posts, bridges, wharves, railway-sleepers, caskstaves, palings, and for veneer, plywood, building-board industries, etc. Also suitable for pulp and rayon. For poles and piles, *E. crebra, E. hemiphloia, E. paniculata, E. propinqua, E. punctata, E. redunca* var. *elata, E. siderophloia* and *E. sideroxylon*, which are resistant to fungi and termites, are exploited; for durability *E. camaldulensis, E. gummifera, E. leucoxylon, E. melliodora,* and *E. microcorys* are preferred. For bridges, wharves, railway-sleepers, caskstaves and palings, the timber of *E. camaldulensis, E. crebra, E. gummifera, E. hemiphloia, E. paniculata, E. polyanthemos, E. punctata* and *E. regnans* is exploited. For veneer and plywood, the timber of *E. diversicolor*, *E. gigantea* and *E. regnans* is used. The timber of *E. eugenioides, E. gummifera, E. obliqua, E. pilularis, E. regnans* and *E. resinifera* is utilized for hardpressed, wood-fibred building-boards.

Fuel—Most of the woods are good firewood. Older trees tend to have higher density and burn better (4800 kcal/kg). Mysore gum, however, slowly burns and yields smokeless charcoal (7550 kcal/kg). Timbers of some species, such as *E. calophylla, E. camaldulensis, E. paniculata, E. redunca* var. *elata, E. sideroxylon* and *E. tereticornis*, are converted into charcoal. Methyl alcohol, acetone and acetate of lime are obtained as byproducts. Certain species, such as *E. regnans* and *E. obliqua*, have appreciable potential for sugar, which can be utilized for alcohol.

Bark—Oxalic acid (yield, 40–45%) can be extracted from the bark. Most barks of many species yield important tannins. Some tannin-yielding introduced species are: *E. caldocalyx* (25–30%),*E. crebra, E. paniculata, E. redunca* var. *elata, E. siderophloia* (6–30%) and *E. sideroxylon* (14–40%).

Essential Oils—On steam-distillation, leaves and branchlets of several species yield essential oils. These vary in composition, and may be grouped under: (*i*) pharmaceutical or medicinal oils, (*ii*) industrial oils, and (*iii*) perfumery oils. Cineole is the important constituent of medicinal oils. They are obtained from *E.elaeophora, E. leucoxylon* and *E. sideroxylon* in Australia. In India, oil, however, is extracted from *E. globulus* only.

Phellandrene and piperitone are the principal constituents of industrial oils, formerly used in mineral floatation. Out of the species exploited for such oils in Australia, *E. dives*, introduced into India, is one of the principle sources of *l*-piperitone used for synthetic thymol and menthol. For perfumery, oils rich in terpeniol, citronellal, geranyl acetate and eudesmol are employed. *E. citriodora*, which contains citronellal, is also exploited in India for fuel; and for ornament are: *E. elaeophora, E. leucoxylon, E. macarthuri, E. sideroxylon* and *E. smithii*.

Agroforestry—Since *Eucalyptus* spp are adaptable to various climatic and edaptic conditions and also give minimum shade, the species can be combined with various types of crops, depending upon the need. *Eucalyptus* spp, suited to arid and semi-arid areas, can be combined with arable crops only at a wide spacing (4m×4m or more) and only for the first 3–4 years of the rotation. In higher rainfall areas, moisture-loving species can be combined with several crops, such as cereals, oilseeds, pulses, vegetables and spices. They can successfully be grown in between rows for several years, as the thin canopy of *Eucalyptus* does not prevent much light.

Under coppice-management, further intercrops can be planted for 2–3 years after clear-felling. A system of continuous intercropping may emerge from trials of sequential felling of alternate or every third row, which can also effectively maintain wider spacing for larger trees.

Social Forestry—*Eucalyptus* spp have also been recommended for and planted under social forestry. They are cultivated for energy for commercial utilization. Large-scale plantation of shelterbelts, windbreaks, hedges and on roadsides have become very common. The species have gained importance because of fast rate of growth and high quantity of biomass and ease of cultivation. These plantations, which yield high returns, have become popular in various States, such as Gujarat, and are gaining importance inspite of the reported disadvantages and deleterious effects on soils.

Several species provide bee-pasture.

THE EUCALYPTUS DILEMMA

Eucalyptus spp have become popular for large-scale plantation, but these are suspected to cause many short- and long-term damages, leading to serious ecological disturbance of vital resources, such as soil and water, and biological productivity in the land and affect even the wildlife and the wastelands. Some countries have even banned the planting of eucalypts.

Water and Nutrient Requirements—The plantations consume more water than natural forests and do not properly regulate the flow due to lack of undergrowth and proper mulch, leading to deficiency in soil-moisture and groundwater, where rainfall is less. Eucalypts are often planted where there have been no trees before. Under these circumstances, the yield of water in the catchment is reduced and watertable receds. The effect is maximum when the trees are young and rapidly growing. Eucalypts affect the life-supporting system in arid regions by interfering with the processes which replenish soil-moisture and recharge groundwater, leading to aridization and groundwater depletion.

Nutritional requirements are also excessively high. The scanty leaf-litter is not easily biodegraded because they pollute the soil restricting the activity of the decomposing organisms; hence, there is no quick release of nutrients locked in leaf-litter, impairing the fertility of the forest.

Erosion—Besides, eucalypts are not ideal trees for erosion-control under dry conditions, as ground vegetation is suppressed by the competition of strong surface-roots and thin crown. The combination of large requirement of water and nutrients for the eucalypts in drylands and suppression of vegetation underneath ecologically disturbs the land, leading to economic disturbances. The effect of these plantations will also be felt in the adjoining fields. It was recently shown that the leachates of leaf-litter of *E. camaldulensis* and *E. citriodora* can selectively be toxic to annual herbs, and to crops, such as *Abelmoschus esculentus, Capsicum annuum* and *Lycopersicum esculentum* and to a certain extent to *Zea mays*. Planting on degraded sites may be beneficial but replacing the indigenous forests with eucalypts is probably not advisable.

Wildlife—Observations have shown that the number and diversity of wildlife, especially mammals, birds and insects, are less in exotic plantations of eucalypts than in natural forests. This may be due to monoculture.

Some consider that the indiscriminate or injudicious introduction creates environmental problems, and, unfortunately, the eucalypts are blamed for the mistakes of man. Therefore, planting of eucalypts, especially on a large scale, should be undertaken only after a careful assessment of the ecological, social and economic consequences.

SOME PROMISING *Eucalyptus* SPP FOR WASTELANDS

E. camaldulensis Dehnh. syn. *E. rostrata* Schlecht. (REDGUM, RIVER REDGUM) is usually a slender-stemmed, very fast-growing tree, up to 25m, with erect or spreading branches and a smooth, pink or cream or white bark and drooping foliage, introduced on the hills. Grows in many climates from tropical to subtropical and thrives on relatively poor soils and in areas where dry season prolongs. Drought- and frost-resistant than many species; withstands high temperatures during summer and hardy down to 3°C. Needs

400 mm rainfall for commercial plantations, although grows well in drier areas; seasonal flooding or a high watertable is useful. Well adapted for growing in moist swampy localilties, it grows on saline and alkaline soils, etc. Found to be suitable for growing in arid areas also. Plantations produce large amount of wood even in the first year. Commonly planted in dry areas along roadsides, for shelterbelts and recommended for agro- and social forestry. Valued as beepasture.

UTILIZATION

Reclamation—Recommended for skeletal, saline, alkaline, arid soils, sand-dunes, ravines, deep sandy, sandy loam, waterlogged soils, shallow alluvial soils, non-calcareous soils and *kankar* pans; also for mine-spoiled sites, field-boundaries, and for *terai* and *babhar* zone.

Timber—Durable and resistant to termites. General constructions, railway-sleepers, felloes, piles, posts and pavings; and paper-pulp. Yields tannins (2–14%).

Fuel—Excellent fuel (4800 kcal/kg).

Others—Bark: Yields tannins (3.3–16.0%), and a gum, commercially known as EUCALYPTUS GUM OR EUCALYPTUS KINO OR REDGUM. Astringent, used in diarrhoea, dysentery, relaxed sore throat, cuts, etc. *Leaf:* Yields an essential oil (0.27–1.85%); contains phellandrene, cineole (8–10%), *p*-cymene, cuminal, phellandral and geraniol. Active against common dermophytes. Suitable to treat chronic dysentery. Along with twig, yields tannins (5–11%). *Flower:* Honey is clear or pale, with a mild, pleasant flavour.

E. citriodora Hook. syn. *E. maculata* Hook. var. *citriodora* F. Muell. (LEMON-SCENTED GUM) is an attractive, very fast-growing, straight-boled tree (45 m/4.0 m), with an open, graceful crown of narrow, pendulous foliage with a white, red or faintly bluish bark, grows in the plains of North India and sub-montane tract, and cultivated in Karnataka, Tamil Nadu and Kerala. Grows from tropical to subtropical climate on soils which are generally poor and gravelly, including podzols, residual podzols of lateritic origin and infertile clays; withstands high temperatures and light frosts; requires at least 600 mm rainfall. Plantations for oil are established through nursery-raised seedlings and should be pruned to yield more of foliage; leaves from suckers and stumps are allowed to grow for oil.

UTILIZATION

Reclamation—Recommended for reclaiming hills, skeletal soils, ravines, and deep and narrow gullies, semi-moist and non-forest localities.

Esteemed as a beepasture; yields large quantities of quality honey.

Timber—General construction, carriage-building, ship-building, mineprops, poles, tool-handles, railroad-ties and -sleepers, wood-pavings; and paper-pulp.

Fuel—Steadily burns; converted into charcoal.

Others—*Bark:* Yields a KINO, used in diarrhoea and dysentery; possesses antitubercular agent citriodorol and antibacterial agent, 7-methyl-kaempferol. Contains tannins (3.05–48.2%). *Leaf:* Yields a lemon-scented oil (0.5–2.0%), rich in citronellal (65–80%) and citronellol (15–20%); young, mature leaves give higher yields of oil, rich in citronellal; possesses good antimicrobial properties. Used for flavouring dental preparations, and soaps and perfumes. Extract exhibits antidiabetic properties in experimental rabbits.

E. eugenioides Sieb. ex Spreng. syn.? *E. globoidea* Blakely; *E. scabra* Dum.-Cours. (WHITE STRINGYBARK) is a moderate-sized to fairly tall, ornamental tree, with dense, dark, shining foliage and almost horizontal side branches, grows well on the Nilgiri and Palni hills; also on Shimla hills at 1200–1600 m.

UTILIZATION

Reclamation—Recommended for skeletal and laterite soils and hill-soils, and for moist and very moist areas.

Timber—General construction, sleepers, fence-posts, flooring and paving-blocks; and pulp.

Others—*Bark:* Suitable for mats and packing. *Leaf:* Yields an essential oil (0.75%); contains mainly α-pinene, cineole (30%) and a sesquiterpene.

E. globulus Labill. (BLUEGUM TASMANIAN BLUEGUM EUCALYPT) is a fast-growing, large tree, *c* 90m or more, with a clear, straight bole in forests, branching in the open, having deciduous bark in long, thin strips or sheets, young leaves cordate-ovate covered with a bluish-white bloom, adult lanceolate, introduced into India for fuel, grows well on the Nilgiri (1500–2490 m), Annamalai and Palni hills, Shimla (1200–2100 m) and at Shillong; also for hills of Uttar Pradesh and Himachal Pradesh. Cool, moist and equitable climate, and deep, fertile non-calcareous or saline soils are favourable. Propagtaed from seed, and transplanting in baskets gives good results; viability reduces with storage; susceptible to drought, frost and fire; readily and rapidly coppices.

UTILIZATION

Reclamation—Recommended for skeletal, laterite and hillsoils; moist to very moist localities also suitable. Possesses dense under ground rootsystem and prevents erosion; leaf-litter is also provided.

A source for honey.

Timber—Ship-building, godowns, sheds, stations and platforms, fence-posts, rough carpentry; and pulp.

Fuel—Mainly used as fuel (4962 kcal/kg) in India; also converted into charcoal.

Others—Plant: Yields a gum-resin, used as astringent in diarrhoea, and in relaxed condition of pharynx. *Leaf:* Yields an essential oil (0.90–1.25%; cineole, 75%); possesses mycotoxic and antibacterial properties. Used as insect-repellant and enters into germicidal and disinfectant, deodorizing and antiseptic preparations. Used to remove incrustations in boilers and locomotives. Possesses antiseptic, rubefacient, stimulating, expectorant properties. Extract very effective against *Scytalidium* sp which causes diseases of skin and nail; also exhibits antidiabetic action in animals. Infusion used in *post-partum* hemorrhage and asthma; also useful in diabetes mellitus. Flower and fruit also yield the essential oil.

E. gomphocephala A. DC. (TUART) is a tall tree, up to 42 m/7.3 m or more; trunk frequently crooked or forked, with fibrous, dull and pale-grey bark, introduced into India, needs a minimum annual rainfall of 300 mm. Grows well on free-draining sands and tolerates up to 25% active calcium, and also slightly saline soils, but not waterlogging; tolerates lower fertility than *E. camaldulensis*.

UTILIZATION

Reclamation—Recommended for saline, alkaline soils. Widely planted to stabilize sand-dunes, and for windbreaks and soil-protection and as an avenue- and shade-tree.

Timber—Construction; fence-posts, and stakes. Seed-raised plants yield large quantity of timber.

Fuel—Makes good firewood.

Others—Leaf: Yields an essential oil (0.03–0.60%).

E. hemiphloia F. Muell. syn. ? *E. moluccana* Roxb. (GREYBOX) is a moderately large tree, with drooping foliage, bark peeling off in flakes or long strips, introduced and grown in the plains and on the hills, up to 1500 m, under irrigation; growth fairly rapid.

UTILIZATION

Reclamation—Recommended for skeletal, laterite and hillsoils and moist to very moist areas.

A good beepasture.

Timber—Posts, buildings, wheelwork, and toolhandles.

Fuel—Used as firewood.

Others—*Bark:* Yields a KINO; contains eudersenin and aromadendrin. *Leaf:* Yields an essential oil (0.4–0.9%).

E. microtheca F. Muell. (FLOODED-BOX COOLABAH) is a stunted bush, barely 3 m, or a tree over 20 m/3 m, depending upon site, with spreading branches.

UTILIZATION

Reclamation—A fast-growing, drought-resistant tree for arid areas, flourishes on dry lands with high temperatures and on alkaline, skeletal and ravinous soils; also grows on heavy clays or silty clay-loams, and also seasonally inundated watercourses. Grows well even under waterstress, and can withstand a dry spell up to seven months. A valuable tree for conservation and erosion-control, reclamation of mined areas, and shade in torrid regions; good for shelterbelts and windbreaks and almost free from insects and fungi.

Timber—Durable poles, and fence-posts.

Fuel—A very good firewood; converted into charcoal.

Others—*Bark:* Yields tannins (8.9%). *Leaf:* Yields an essential oil (0.48–1.45%).

E. occidentalis Endl. (FLAT-TOPPED YATE, SWAMP YATE) is a tree, up to 28 m/2.4 m, with flat-topped umbrella-like crown.

UTILIZATION

Reclamation—A drought-tolerant species. Recommended for growing on very saline and alkaline soils, arid areas and may be suitable for unusually difficult sites.

Timber—Constructional work and for products requiring heavy and strong wood.

Fuel—Steadily burns as firewood.

E. paniculata Sm. (GREY IRONBARK) is a rather slow-growing, moderate-sized tree; grows well in the plains of North India, and cultivated on the Nilgiri and Shimla hills below 1200 m.

UTILIZATION

Reclamation—Commonly planted for ornament and gap-filling; withstands poor soils and suitable for skeletal, laterite and hillsoils.

Timber—Posts, wheel-work, carriage-building, general construction.

Fuel—Suitable for making charcoal.

Others—Bark: Yields tannins (7.0–30.0%). *Leaf:* Yields an essential oil (0.1%).

E. robusta Sm. syn. *E. multiflora* Poir.; *E. rostrata* Cav. (SWAMP-MAHOGANY) is a moderate-sized, handsome, symmetrically branched tree, with large leaves, grown in the plains of northern India, sub-Himalayan tract and on the Nilgiri and Kodagu hills.

UTILIZATION

Reclamation—Prefers moist situations and recommended for afforestation of hills, cold deserts, plains, alkaline and skeletal soils, low-lying waterlogged areas, coastal saline soils and coastal saline alluvium and mined areas and mine-spoiled heaps.

Valuable for bee-keeping.

Timber—Building, wheel-work, fence-posts, and paper-pulp.

Fuel—A good firewood (4908 kacl/kg).

Others—Leaf: Yields an essential oil (0.33%) and tannins (12%). Leaf and stembark extract possesses semen-coagulant properties.

E. saligna Sm. (SYDNEY BLUEGUM; SALIGNA GUM) is a large tree, with deciduous, smooth, grey bark, grown in the plains of northern India, especially cooler parts; also grown on the Nilgiri, Palni and Kodagu hills. Prefers deep, moist soils and sensitive to drought. Can be sown in late September and transplanted early in the following hot weather.

UTILIZATION

Reclamation—Recommended for skeletal soils, laterite soils, hillsoils, coastal saline beaches, alkaline and waterlogged soils and for other wastelands.

Timber—Ship-building, carpentry; pitprops; and pulp.

Leaf—Yields an essential oil (up to 4%); contains cineole (25.2%).

E. siderophloia Benth., non auct. (BROAD-LEAVED RED IRONBARK) is a large tree, with straight stem and deeply furrowed persistent bark, cultivated on the Nilgiris; also grows well in the plains of North India. A frost-resistant plant, grows on dry soils.

UTILIZATION

Reclamation—Planted for afforestation.

Timber—Tool-handles, posts; piles, vehicles, and flooring.

Others—Bark: Yields a KINO; along with leaf yields tannins (6–30%). *Leaf*: Yields an essential oil (0.06%).

E. sideroxylon A. Cunn. ex. Woolls (RED IRONBARK) is a moderate-

TABLE 1—*EUCALYPTUS* SPECIES INTRODUCED INTO INDIA FOR AFFORESTATION, RECLAMATION OF WASTELANDS AND FOR TIMBER, PULP AND FUEL

Species	English Name	Wastelands	Essential oil/ Tannins (%)
E. acmenioides Schau. (? *E. triantha* Link)	White Mahogany	Hills, moist to very moist soils; skeletal soils; laterite soils.	E 0.90
E. aggregata Deane & Maiden	Blackgum	Dry, cold desert.	—
E. alba Reinw. ex Blume	Whitegum	Plains.	TL 3.75
E. baueriana F. Muell.	Bluebox	Plains.	—
E. behriana F. Muell.	—	Arid zone.	—
E bicolor A. Cunn. ex Hook., non auct.	Blackbox	Hills.	E 0.85
E. bosistoana F. Muell.	Coast Greybox, Bosistor's Box	Plains.	E 0.97
E. botryoides Sm.	Southern Mahogany, Bangalay	Hills; moist to very moist areas; skeletal soils; laterite soils.	E 0.11
E. brachypoda Turcz. (*E. brevifolia* F. Muell.)	—	Arid areas; skeletal and ravinous soils.	—
E. bridgesiana R.T. Baker (*E. stuartiana* F. Muell.)	Applebox	Dry, cold desert.	E 0.40
E. calophylla R. Br. ex Lindl.	Redgum, Marri	Hills and high-level wetlands and waterlogged areas; skeletal soils; laterite soils.	E 0.25
E. camaldulensis Dehnh. (*E. rostrata* Schlecht.)	River Redgum	Arid area; hills and plains; semi-moist, non-forest localities; skeletal soils; saline and alkaline soils; *kankar* pans; waterlogged soils; sand-dunes; sandy loam; deep sandy loam; shallow alluvial soils; ravines; mine-sites especially of lignite, bauxite and tin; roadsides; shelterbelts; windbreaks; field-boundaries; in *terai* and *babhar* zone.	E 0.27-1.85 TB 3.3-16.0 TT & L 5-11 TW 2-14

(*contd.*)

TABLE 1—*EUCALYPTUS* SPECIES INTRODUCED INTO INDIA (*Contd.*)

Species	English Name	Wastelands	Essential oil Tannins (%)
E. cineria F. Muell. ex Benth.	ARGYLE APPLE, SPIRAL EUCALYPTUS	Dry, cold desert.	E 1.2
E. citriodora Hook. (E. *maculata* Hook. var. *ctiriodora* F. Muell.)	LEMON-SCENTED GUM	Hills and plains; semi-moist non-forest area; skeletal soils ravines; deep, narrow gullies.	E 0.5-2.0 TB 3.05-48.2
E. cladocalyx F. Muell.	SUGARGUM	Hills.	E 0.096 TB 25-30
E. coccifera Hook. f.	TASMANIAN SNOWGUM	Dry, cold desert.	—
E. coolabah Blakely & Jacob	—	Deep and shallow, sandy soils.	—
E. cornuta Labill.	YATETREE	Hills.	E 1.20
E. crebra F. Muell.	NARROW-LEAVED IRONBARK	Hills and plains; alkaline and saline soils; waterlogged lands.	E 0.16-0.93 TB 7.0-30.0
E. dalrympleana Maiden	MOUNTAIN-GUM	Dry, cold desert.	—
E. dealbata A. Cunn. ex Schau.	TUMBLE-DOWN GUM	Arid zone.	E 0.86
E. deanei Maiden	DEANE'S GUM	Plains.	—
E. deglupta Blume	MINDANAO GUM	Hills; skeletal soils; laterite soils; recommended for Kerala coastal region.	TB 3.0
E. delegatensis R. T. Baker (*E. gigantea* Hook. f., non. Dehnh.)	ALPINE ASH	Dry, cold desert.	—
E. dives Schau.	BROAD-LEAVED PEPPERMINT	Hills.	E 1.5-5.1
E. eremophila (Diels) Maiden	TALL SAND-MALLEE	Arid zone.	—
E. erythronema Turcz.	RED-FLOWERED MALLEE	Arid zone.	TB 25-30
E. eugenioides Sieb. ex Spreng. (?*R. globoidea* Blakely; *E. scabra* Dum.-Cours.)	WHITE STRINGYBARK	Hills; moist to very moist soils; skeletal soils; laterite soils.	E 0.75
E. exserta F. Muell.	BENDO	Hills.	—

(*contd.*)

TABLE 1—*EUCALYPTUS* SPECIES INTRODUCED INTO INDIA (*Contd.*)

Species	English Name	Wastelands	Essential oil/ Tannins (%)
E. ficifolia F. Muell.	RED-FLOWERING GUM	Hills; alkaline soils.	E 0.18
E. flocktoniae Maiden	MERRIT	Arid zone.	—
E. globulus Labill.	BLUEGUM	Hills; moist to very moist areas; skeletal soils; laterite soils; controls erosion with its dense rootsystem; provides leaf-litter.	E 0.90-1.25
E. gomphocephala A. DC.	TUART	Semi-arid areas; alkaline and saline soils; sand-dunes, windbreaks; avenue- and shade-tree.	E 0.03-0.60
E. goniocalyx F. Muell. ex Miq.	MOUNTAIN GREYGUM	Hills; saline and alkaline soils.	E 1.0
E. grandis W. Hill ex Maiden	ROSEGUM	Hillsoils at higher elevations; difficult, eroded areas; deep slopes; high-level grasslands, wetlands and watgerlogged areas as in Kerala; skeletal soils; laterite soils; field-boundaries; in *terai* and *babhar* zone; bauxite- mined areas.	
E. gummifera (Gaertn.) Hochr. (*E. corymbosa* Sm.)	RED BLOODWOOD	Hills.	E 0.06
E. gunnii Hook. f.	CIDERGUM	Dry, cold desert.	E 0.68
E. hemiphloia F. Muell. (?*E. moluccana* Roxb.)	GREYBOX	Hills and plains; moist to very moist areas; skeletal soils; laterite soils.	E 0.40-0.90
Eucalyptus Hybrid (*E. botryoides* × *tereticornis* from Mysore) (*E. robusta* × *tereticornis* from Mysore)	MYSORE GUM	Hillslopes; semi-moist to very moist soils; non-forestry localities; skeletal soils, laterite soils; coastal sandy soils; saline soils; alkaline soils; sodic soils; ravines; eroded land; dry areas; red soils; deep sandy soils; shallow sandy loam; roadsides; shelterbelts; for agroforestry.	TB 3.16
E. intertexta R. T. Baker	GUM-BARKED COOLABAH	Arid zone	—

(*contd.*)

TABLE 1—*EUCALYPTUS* SPECIES INTRODUCED INTO INDIA (*Contd.*)

Species	English Name	Wastelands	Essential oil/ Tannins (%)
E. johnstonii Maiden	Johnston's Gum	Dry, cold desert.	—
E. lansdowneana F. Muell.	Crimson Malleebox	Arid zone.	—
E. largiflorens F. Muell. (*E. bicolor* auct., non A. Cunn. ex Hook.)	—	Arid zone.	—
E. lesouefii Maiden	Lesouef's or Gold-field's Blackbutt	Arid zone.	—
E. leucoxylon F. Muell.	Yellowgum, White Ironbark	Hills; alkaline soils.	E 1.5-2.5
E. longifolia Link & Otto	Woollybutt	Hills.	E 0.54
E. macror(r)hyncha F. Muell.	Red Stringybark	Hills.	E 0.29
E. maidenii F. Muell.	Maiden's Bark	Hills.	E 1.0
E. megacornata C. Gardn.	Warted Yate	Alkaline soils.	—
E. melanophloia F. Muell.	Silver-leaved Ironbark	Arid zone; deep sandy soils; sand-dunes; shallow soils with *kankar* pans; shallow sandy loam; saline soils; alkaline soils.	E 0.11-0.35
E. melliodora A. Cunn. ex Schau.	Yellow Box, Honeybox	Hills and plains.	E 0.87 TB 12.0
E. microcarpa Maiden	Green-leaved Box	Hills.	—
E. microcorys F. Muell.	Tallowwood	Hills.	E 0.71-0.73
E. microtheca F. Muell.	Flooded-box Coolabah	Arid areas; plains; alkaline, skeletal and ravinous soils; mined sites; shade-tree.	E 0.48-1.45 TB 8.9
E. morrisii R. T. Baker	—	Alkaline soils.	E 1.50
E. muellerana Howitt	Yellow Stringybark	Hills.	—
E. niphophila Maiden & Blakely	Snowgum	Dry, cold desert.	—
E. obliqua L' Hérit.	Messmate Stringybark	Hills.	E 0.70 TL 17.2

(*contd.*)

TABLE 1—*EUCALYPTUS* SPECIES INTRODUCED INTO INDIA (*Contd.*)

Species	English Name	Wastelands	Essential oil/ Tannins (%)
E. occidentalis Endl.	FLAT-TOPPED YATE, SWAMPYATE	Arid zone; saline and alkaline soils.	—
E. ochrophloea F. Muell.	—	Arid zone.	—
E. odorata Behr. & Schlecht	PEPPERMINT-BOX	Alkaline and saline soils; drought-affeted area.	E 1.87 TB 1.46
E. oleosa F. Muell.	GIANT MALLEE	Arid zone; sand-dunes.	TB 2.1-8.6 (various vars.)
E. ovata Labill. (*E. padulosa* Labill.)	SWAMPGUM	Dry, cold desert.	E 0.14-1.28
E. paniculata Sm.	GREY IRONBARK	Hillsoils; plains; skeletal soils; laterite soils.	E 0.1 TB 7-30
E. parviflora Cambage	SMALL-LEAVED SNOWGUM	Dry, cold desert.	—
E. patens Benth.	SWAN-RIVER BLACKUTT	Plains.	—
E. patentinervis R. T. Baker (probably a hybrid : *E. robusta* × *E. tereticornis*)	—	Plains.	E 0.26
E. pilularis Sm.	BLACKBUTT	Hills; moist to very moist soils; skeletal soils; laterite soils.	E 0.11
E. piperita Sm.	SYDNEY PEPPERMINT	Hills.	—
E. planchoniana F. Muell.	BASTARD TALLWOOD	Hills.	E 0.014
E. polyanthemos Schau.	SILVER-DOLLAR GUM, REDBOX	Hills.	E 0.83
E. populnea F. Muell. (? *E. populifolia* Hook.)	BIMBLEBOX	Arid zone; alkaline and saline soils.	E 0.6
E. propinqua Deane & Maiden	SMALL-FRUITED GREYGUM	Hills; moist to very moist soils; skeletal soils; laterite soils.	E 0.24
E. punctata DC.	GREYGUM	Hills; moist to very moist soils; skeletal soils; laterite soils.	E 0.63-1.19
E. racemosa Cav., non auct.	SNAPPYGUM	Dry, cold desert.	—
E. redunca Schau.	BLACK MARLOCK	Hillslopes and flats; poor and badly drained soils.	E 1.2 TB,TW (conc.) 60-63

(*contd.*)

TABLE 1—*EUCALYPTUS* SPECIES INTRODUCED INTO INDIA (*Contd.*)

Species	English Name	Wastelands	Essential oil/ Tannins (%)
E. regnans F. Muell. (*E. amygdalina* Labill. var. *regnans* F. Muell.)	Mountain Ash, Giant Gum	Hills; withstands snow.	E 0.81
E. resinifera Sm.	Red Mahogany	Hills.	E 0.42
E. robusta Sm. (*E. multiflora* Poir.; *E. rostrata* Cav.)	Swamp Mahogany	Hills; cold desert; plains; skeletal soils; coastal saline and saline alluvium beaches; alkaline soils; mined areas and spoiled heaps; low-lying waterlogged areas.	E 0.33 TL 12
E. rudis Endl.	Desert Gum	Hills and plains; arid zone; semi-moist, non-forest areas; skeletal soils; saline, saline and sandy soils; swampy, waterlogged areas.	E 1.2 TB 15
E. saligna Sm.	Sydney Bluegum, Saligna Gum	Hills and plains; moist to very moist soils; coastal-saline areas and sandy beaches; alkaline soils; waterlogged areas; other wastelands.	E 0.12-4.0
E. salmonophloia F. Muell.	Salmon-gum	Arid zone.	—
E. salubris F. Muell.	Gimlet Gum	Arid zone.	—
E. siderophloia Benth., non auct.	Broad-leaved Red Ironbark	Hills and plains.	E 0.06 TB, TL 6-30
E. sideroxylon A. Cunn. ex Woolls	Red Ironbark	Hills; semi-arid areas; saline soils; alkaline soils; shallow alluvial soils.	E 1.5-2.5 TB 7-40
E. stricklandii Maiden	Strickland's Gum	Arid zone.	—
E. tereticornis Sm. [*E. umbellata* (Gaertn.) Domin]	Forest Redgum	Hills and plains; moist to very moist areas; skeletal soils; laterite soils; alkaline and saline soils; mined areas; field-boundaries; in *terai* and *babhar* zone; agroforestry; can be planted on sandy riverine deposits and in copper- and bauxite-mined areas.	E 0.66-3.57 TB 5.64
E. terminalis F. Muell.	—	Arid zones; deep sandy soils with *kankar* pans, sand-dunes; shallow, sandy-loam soils; alkaline soils.	—

(*contd.*)

TABLE 1—*EUCALYPTUS* SPECIES INTRODUCED INTO INDIA (*Contd.*)

Species	English Name	Wastelands	Essential oil/ Tannins (%)
E. tessellaris F. Muell.	CARBEEN OR MORETON BAYASH	Arid zones; sand-dunes; shallow, sandy soils with *kankar* pans; alkaline soils; calcareous soils.	E 1.01
E. torquata Luehm.	CORALGUM	Arid zone.	—
E. torelliana F. Muell.	CADAGI	Alkaline soils.	E 0.20
E. transcontinentalis Maiden	MORREL, MALLEE, MARLOCK	Arid zone.	—
E. vernicosa Hook. f.	VARNISH-LEAVED GUM	Dry, cold desert.	—
E. viminalis Labill.	MANNAGUM	Hills.	E 0.5-1.4
E. viridis R.T. Baker	—	Arid zone.	E 1.5-2.1
E. wandoo Blakely	WANDOO	Arid zone.	—

E = Essential oil; T = Tannin; B = Bark; L = Leaf; W = Wood; T = Twig.

sized to large tree, with rough, persistent bark, narrow, silvery leaves, grown on the Kumaun hills, Dehra Dun, and in Shimla, at 1200–1800 m.

UTILIZATION

Reclamation—Recommended for semi-arid, saline, alkaline and shallow alluvial soils.

Valued as bee-pasturage.

Timber—Poles, piles, and railway-sleepers.

Fuel—Suitable for charcoal.

Others—*Bark:* Yields tannins (14–40%). *Leaf:* Yields an essential oil (1.5–2.5%); medicinally used.

E. tereticornis Sm. syn. *E. umbellata* (Gaertn.) Domin. (FOREST REDGUM) is a fast-growing, tall, handsome tree, with smooth, more or less deciduous, greyish bark, one of the most successful species at low elevations, grows well on the Nilgiris, in Maharashtra, Uttar Pradesh, Punjab and Himachal Pradesh. A frost-resistant tree, requires a fairly deep soil.

UTILIZATION

Reclamation—Recommended for arid areas, skeletal soils, laterite soils, hillsoils and alkaline and saline soils, sandy riverine deposits, mined areas and also moist to very moist areas; also recommended for planting on field-boundaries, in *terai* and *babhar* zone and for agroforestry.

Timber—Engineering construction, sleepers, ship-building, flooring; and paper-pulp.

Fuel—Can be used as fuelwood.

Others—*Bark:* Yields tannins (5.64%). *Leaf:* Yields an essential oil (0.66–3.57%); contains cineole (10.4%). Oil useful in catarrh and cold.

TABLE—2 SPECIES TRIED ON HILLS AND IN PLAINS WITHOUT MUCH SUCCESS

E. alpina Lindl.	Gramplan Stringybark
E. andrewsii Maiden	New England Blackbutt
E. baileyana F. Muell.	Bailey's Stringybark
E. cosmophylla F. Muell.	Cupgum
E. decipiens Endl.	
E. diversicolor F. Muell.	Karrigum
E. erythrocorys F. Muell.	Illyarie
E. guilfoylei Maiden	Yellow Tingle
E. haemastoma Sm.	Scribbly Gum
E. lehmannii Benth.	Bushy Yate, Lehmann's Gum
E. lindleyana DC. (*E. numerosa* Maiden)	River-peppermint
E. macarthuri Deane & Maiden	Camden Woollybutt
E. macrandra F. Muell.	Long-flowered Marlock
E. macrocarpa Hook.	Bluebush
E. marginata J. Donn. ex Sm.	Jarrah
E. platypus Hook. (*E. obcordata* Turcz.)	Round-Leaved Moort
E. smithii R.T. Baker	Blackbutt Peppermint
E. stellulata Sieb. ex DC.	Blacksally
E. umbra R. T. Baker	White or Bastard Mahogany
E. urnigera Hook. f.	Urn-fruited Gum
E. virgata Sieb. ex Spreng. (probably hybrid: *E. luehmanniana* F. Muell. x *E. obtusiflora* DC.)	

EULALIOPSIS Honda (*Poaceae)*

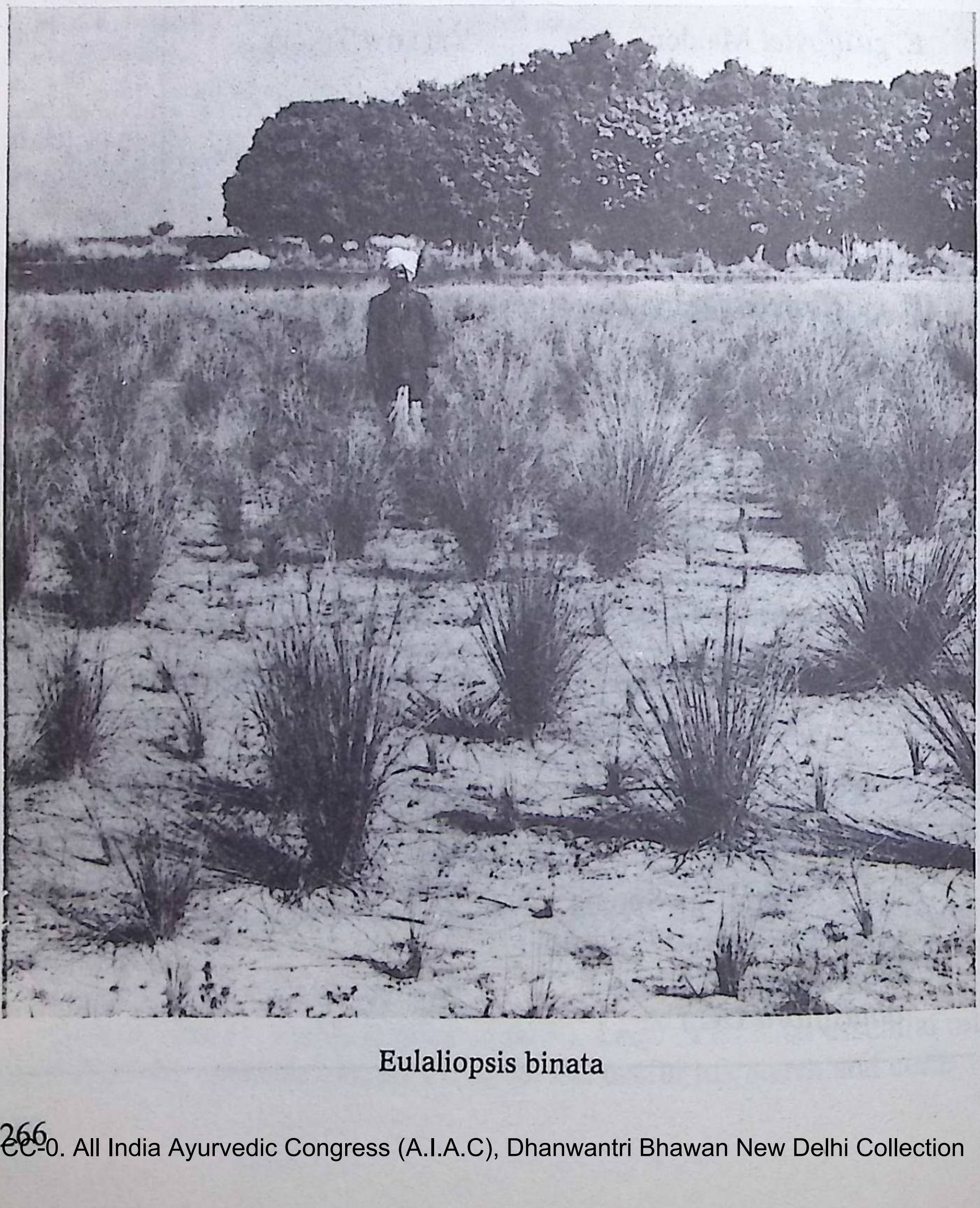
Tufted perennials; Indo-Malayasia, the Phillippines, China and Taiwan; 2 spp in India.

E. binata (Retz.) C.E.Hubbard syn. *Ischaemum angustifolium* Hack.; *Pollinidium angustifolium* Haines; *P. binatum* (Retz.) C.E.Hubbard

SABAIGRASS

Beng & Hindi–*Sabai, baibui;* Oriya–*Bagali, baibui.*

Habit—A tufted, perennial grass, 60–150 cm. *Root*—with a thick, woody extensive, rhizomatous rootstock. *Culm*—erect, slender, shiny, woolly tomentose at base. *Leaf*—narrow, linear, 90–120 cm × 3.5 mm, glabrous above, hirsute below. *Inflorescence*—racemes 2–4, 2.5–5.0 cm



Eulaliopsis binata

long, on piliform peduncles, pale or whitish brown. *Spikelet*—narrowly elliptic-oblong, 3.5–4.5 mm long. *Seed*—black, minute, light, ellipsoidal caryopsis; winter.

Distribution and Ecology—Almost throughout India; common in Punjab, Bihar, West Bengal, Orissa and Madhya Pradesh; also cultivated in Uttar Pradesh on wastelands. Abundant on dry, bare slopes and forest-blanks of sub-Himalayan areas with 750–1500 mm rainfall. Grows well on well-drained loams and also on poor soils not subject to waterlogging, sandy *bhur* in Uttar Pradesh and barren *danga* in West Bengal. Drought-, frost- and to a certain extent fire-hardy. A strong light-demander.

Cultivation/Regeneration—Propagated from seed; sown in beds during the break of monsoon; 12-month-old seedlings transplanted in prepared fields at 60 cm × 60 cm; weeding essential. Also vegetatively propagated from divisions of rootstock (*c* 450 kg/ha); starts yielding from the first year; occasional burning improves the yield and quality. Withstands cutting; twice harvested before or during flowering during August–December.

UTILIZATION

Reclamation—Recommended for covering and farming new surface-soils on eroded land and for afforestation and on hilly regions, up to 2000 m; since not eaten by cattle except during scarcity and survives drought, frost and fire because of its extensive rootsystem, its use is highly recommended; prevents soil-erosion and planted on fresh roads, new railway embankments for protection and gullies and ravines; can be grown as intercrop in young *sal* or other plantations on shallow, denuded lands, subject to drought. Recommended for social forestry.

Fodder—Tender grass (crude protein, 5.6–6.1%) may be given as fodder.

Others—Grass: Used for making ropes, mats, slippers, etc.; suitable for conversion into pulp for paper and rayon.

EUPHORBIA Linn. (*Euphorbiaceae*)

Laticiferous herbs, shrubs and small trees; tropical and warm-temperate regions; 68 spp in India.

Many species are succulents, resembling cacti, and inhabit dry, waste places. Also cultivated for ornament and hedges, and planted for reclamation of wastelands; a few considered useful manure. Some are important petrospecies and the potential ones are: *E. acualis* Roxb. (syn. *E. fusiformis* Buch.-Ham.), *E. antiquorum* Linn., *E. antisyphilitica* Zucc., *E. helioscopia* Linn., *E. heterophylla* Linn., *E. hirta* Linn. (syn. *E. pilulifera* auct., non

Linn.), *E. lathyris* Linn., *E. marginata* Pursh., *E. neriifolia* Linn., *E. royleana* Boiss., *E. segetalis* Linn., *E. thymifolia* Linn., *E. tirucalli* Linn. and *E. trigona* Haw. Latex acrid and poisonous in some cases.

E. caducifolia Haines

Rajasthan–*Thor, dandathor*.

Habit —A pale-green, dense, fleshy, dendroid shrub, up to 2 m. *Branch*—cylindrical. *Leaf*—very variable in shape, size and form, 1–9 cm × 1.4 cm, ovate or ovate-oblong. *Fruit*—sharply 3-lobed capsule. *Flowering & Fruiting*—January–April.

Distribution and Ecology—Orissa, Madhya Pradesh, Rajasthan, Gujarat, Maharashtra and Tamil Nadu. In mixed xeromphic thorny forests and woodlands in Rajasthan desert and hills and barren rocky outcrops and upper piedmont plains, with a rainfall of 150–400 mm. Undergrowth of dry, deciduous low forests, covering almost the hillsides wherever it occurs; also found on deep, sand-deposition, alluvial plains and often on gravel.

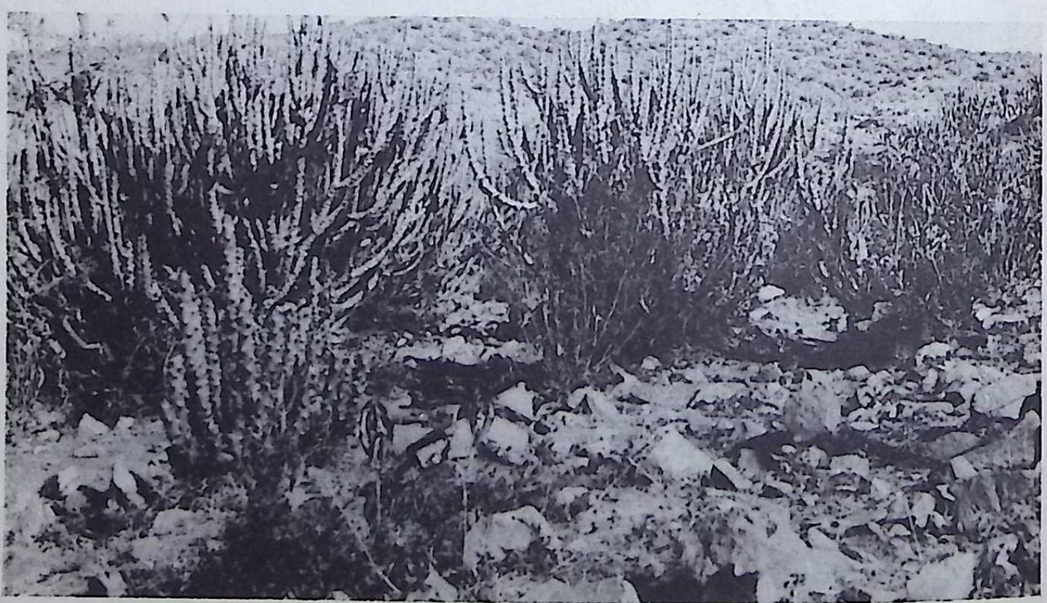
UTILIZATION

Reclamation—Useful for reclaiming the areas mentioned above.

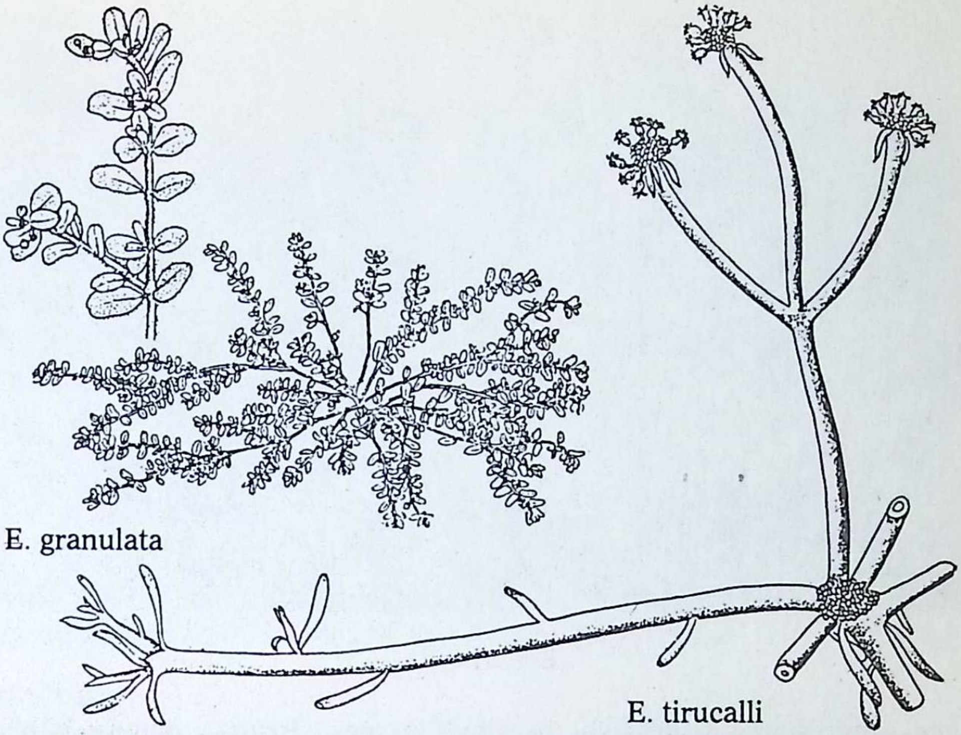
Others—*Leaf:* Eaten as vegetable. *Latex:* Used in coughs; applied onto blisters.

E. granulata Forsk.

Rajasthan—*Dudheli*.



Euphorbia caducifolia



E. granulata

E. tirucalli

Habit—A small, prostrate, hispidly-villose, greenish or purplish herb. *Stem*—prostrate, many. *Root*—with a rootstock. *Leaf*—obliquely obovate, oblong-obovate, 2.5–5.0 cm × 1–3 mm, distichous, on short, leafy branches; February–August. *Fruit*—small, thirsute capsule. *Seed*—brown, 4-angular, with thick mucous; September–December.

Distribution and Ecology—Punjab, Uttar Pradesh, Rajasthan, Gujarat and Maharashtra. Halophyte; found on dry, hilly tract and covers large patches of sandy plains and gravelly fields.

UTILIZATION

Reclamation—Recommended to be grown on the soils mentioned above and also on saline soils.

E. neriifolia Linn.

Beng–*Mansasij;* Guj–*Thor;* Hindi–*Sehund;* Kan–*Yalekalli;* Mal & Tam–*Illakalli;* Mar–*Neyadunga;* Sans–*Snuhi;* Tel–*Aakujemudu.*

Assam–*Hiju;* Bombay–*Minguta;* Punjab–*Gangichu.*

Habit—A succulent shrub or small tree, up to 6 m. *Bark*–reticulate. *Stem*—cylindrical or obscurely 5-angled branches, bearing short, stipular thorns in verticle or spiral line or warty knobs. *Leaf*—fleshy, nearly sessile, deciduous, obovate-oblong, 15–30 cm long, terminal on branches. *Inflores-*

E. neriifolia

cence—involucres yellowish, in small cymes. *Fruit*— deeply-3-lobed capsule 1.25 cm broad. *Flowering & Fruiting*—December–May.

Distribution and Ecology—Found in the Deccan Peninsula; cultivated throughout India. Found on exposed rocky hillslopes and plateaux, near cultivated fields, arid zones of Deccan, sandstone rocks of Rajasthan, in pale-brown to light-brown gravelly, non-calcareous loamy sand, rocky fragments and cobbles coated with lime below in Rajasthan.

UTILIZATION

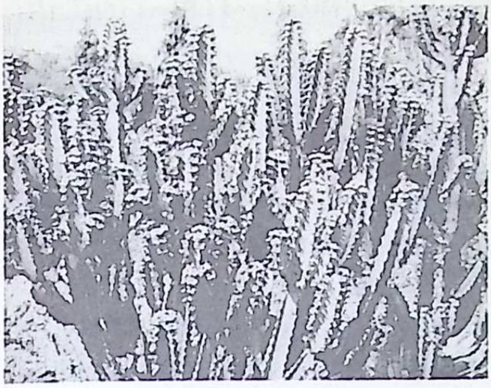
Reclamation—Can be grown on the soils mentioned above for reclamation; grown as hedge, shelterbelts and windbreaks.

Others—Latex: Acrid, rubefacient, purgative and expectorant. Used to remove warts and cutaneous eruptions; can cause dermatitis; juice employed in earache.

E. nivulia Buch.-Ham.

Beng–*Sij;* Hindi–*Katathohar;* Kan–*Dubbakalli;* Mal–*Illakalle*; Mar–*Newranj;* Sans–*Patrasnuhi;* Tam–*Nawagalli;* Tel–*Aakujemudu.*

Habit—An erect, glabrous shrub or a small tree, 9 m. *Branch*—whorled, green, cylindrical, jointed with a pair of sharp, stipular spines, arising from low tubercles arranged in spirals. *Bark*—thick, corky on old plants. *Leaf*—fleshy, linear-oblanceolate or spathulate or obovate-oblong, fleshy, glabrous, up to 30 cm. *Inflorescence*—3-nate, forming small, short-



E. nivulia

E. royleana

peduncled cymes, lateral peduncles bisexual. *Fruit*—capsule, 6 mm broad. *Seed*—smooth.

Distribution and Ecology—Throughout India. Found as undergrowth of dry deciduous low forests and on dry and rocky places.

UTILIZATION

Reclamation— Often grown for hedges, and in arid, sandy areas.

Timber—Wood may be used as a substitute for cork.

Others—Leaf: Juice given as a purgative and diuretic, and for relieving earache.

E. royleana Boiss.

Hindi–*Thor*.

Punjab–*Danda-thor*.

Habit—A very variable, erect, glabrous shrub or small, thorny tree, up to 4.5 m. *Branch*—whorled, 5–7-angled, spiny. *Leaf*—spathulate, thick, deciduous, fleshy. *Inflorescence*—involucres 3–4, 1.5 cm diam, yellow-green, hemispheric. *Fruit*—capsule, 2.1cm diam. *Flowering & Fruiting*— April–May.

Distribution and Ecology—Western Himalayas, at 900–1500 m. Found in dry zone on rocky, dry slopes.

UTILIZATION

Reclamation—Useful as shelterbelts, windbreaks and hedges in northern region and can be grown on dry, rocky slopes.

Fuel—Wood employed as firewood.

Others—Latex: Acrid, cathartic.

E. tirucalli Linn. INDIAN TREESPURGE, MILKBUSH

Beng–*Lankasij;* Guj–*Thor dandalio;* Hindi–*Konpal sehund;*

Kan–*Bontakalli;* Mar–*Shera;* Sans–*Trikantaka;* Tam–*Tirukalli;* Tel–*Kaadajemudu.*

Habit—An erect, unarmed shrub or a small tree, up to 6 m/40–80 cm. *Branch*—green, smooth, cylindric, polished, spreading with whorled, slender branchlets. *Bark*—rough, greenish-brown, cracked. *Leaf*—small, linear-oblong, caducous. *Inflorescence*—chiefly female, small, clustered in the forks of smaller branches; August–September. *Fruit*—dark brown, 8 mm.

Distribution and Ecology—Probably native to Africa, naturalized in India, particularly drier parts of West Bengal and South India; sometimes cultivated.

UTILIZATION

Reclamation—Largely grown as hedge or ornament, almost throughout India; in South India grown as windbreak on seacoast, and recommended as shelterbelts in controlling sand-drifts. Can be grown for reclaiming arsenic-concentrated soils.

Potential petrospecies.

Timber—Suitable for charcoal. Used in gunpowder; used for rafters.

Others—Latex: Rubefacient; used in neuralgia and toothache, cough, asthma and earache. Dried latex contains brittle and lustrous resin, resembling rosin; used in linoleum,oil-shin and leather-cloth industry.

EXBUCKLANDIA R. W. Br. (*Hamamelidaceae*)

Evergreen, tall trees; Indo-Malaysian region; 1 sp in India.

E. populnea (R.Br. ex Griff.) R.W.Br. syn. *Bucklandia populnea* R.Br. ex Griff.; *Symingtonia populnea* (R.Br. ex Griff.) van Steenis

Beng–*Bipli.*

Khasi–*Dieng-doh;* TRADE–*Pipli.*

Habit—A medium-sized to tall, handsome tree, up to 12 m/1.5 m. *Bark*—grey or brown to almost black, rough, coarse-fibred, hard. *Leaf*—broadly ovate to nearly orbicular, dark, glossy-green above, silky when young. *Inflorescence*—2–5-peduncled heads, polygamous. *Flower*—8–20, in each head, hermaphrodite, having variable number of petals. *Fruit*—a free, woody, subglobose capsule. *Seed*—from lower cells winged and fertile and upper non-winged and sterile; 92,400/kg. *Flowering & Fruiting*—November–December; also at other times of the year.

Distribution and Ecology—Eastern Himalayas, from North Bengal, Sikkim, Meghalaya to Manipur, at 1200–2700 m. Grows in the montanetemperate forests with a heavy rainfall of 1250–4000 mm and where snow is practically absent or very light for a short duration and also found in mixed forests.

Cultivation/Regeneration—Seedlings of 5 years and above 1.2 m are transplanted.

UTILIZATION

Reclamation—A very useful plant for afforestation and for the protection of hillslopes liable to collapse; extensively planted by the Forest and Cinchona departments for replanting upon the bared areas. Suitable for North-eastern hills also. Recommended for agroforestry.

Timber—Planking, beams, door- and window-frames, tea-chests, and general carpentry; suitable for plywood and paper-pulp.

Fuel—Good firewood.

Fodder—Excellent.

Others—Bark: Contains tannins (11.0%).

GLEDITSIA Linn. (*Caesalpiniaceae*)

Usually thorny, deciduous trees; Asia, Africa and America; 2 spp in India; a few exotics are cultivated.

G. triacanthos Linn. COMMON HONEYLOCUST, SWEETBEAN

Habit—A fast-growing, hardy, deciduous tree, up to 45 m/5.7 m, with broad, spreading crown of slender, somewhat pendulous, branches, having 7.5–10.0 cm long, simple or branched thorns; some are thornless. *Root*—thick, fibrous. *Leaf*—paripinnate or bipinnate, both forms often on the same tree: leaflets thin. *Flower*—small, greenish-white, polygamous, in racemes. *Fruit*—falcate, twisted pod, up to 50 cm long, containing a thick, sweet, glutinous pulp, with seeds embedded. *Seed*—brown, ovoid to sub-orbicular, many; hot-water treatment needed.

Distribution and Ecology—Native to America, cultivated in India. Grows on all types of soils, but may prefer damp, sandy and low alluvial soils. Dought- and frost-resistant.

Cultivation/Regeneration—Propagated from pre-treated seeds; seedlings transplanted 6m apart; growth fairly rapid and under favourable conditions bears from fourth or fifth year.

UTILIZATION

Reclamation—Recommended for reclaiming the wastelands, mining-sites and for controlling erosion of soil; grown in avenues or hedges. Fixes nitrogen. Valued as a potential treecrop for energy production on farms.

Timber—Fences, furniture, and house-building. Heartwood yields tannins (4.0–4.8%).

Fuel—A good firewood.

Fodder—Leaf eaten by animals. Fruit nutritive (protein, 23.1%) and given as feed to livestock.

Others—Leaf: Contains large amount of ascorbic acid, and hypotensive and antianaemic alkaloid triacanthine; also contains hypoxysin with oxytocic property and a neutral principle with depressor-effect. *Flower:* Source of nectar for honeybees. *Fruit:* Juice and volatile fraction possess marked antibiotic activity. *Seed:* Yields an oil; also yields a gum, used in pharmaceuticals. *Seedcoat:* Rich in tannins.

GMELINA Linn. (*Verbenaceae*)

Trees and shrubs; South-East Asia and tropical Australia; 3 spp in India.

G. arborea Roxb.

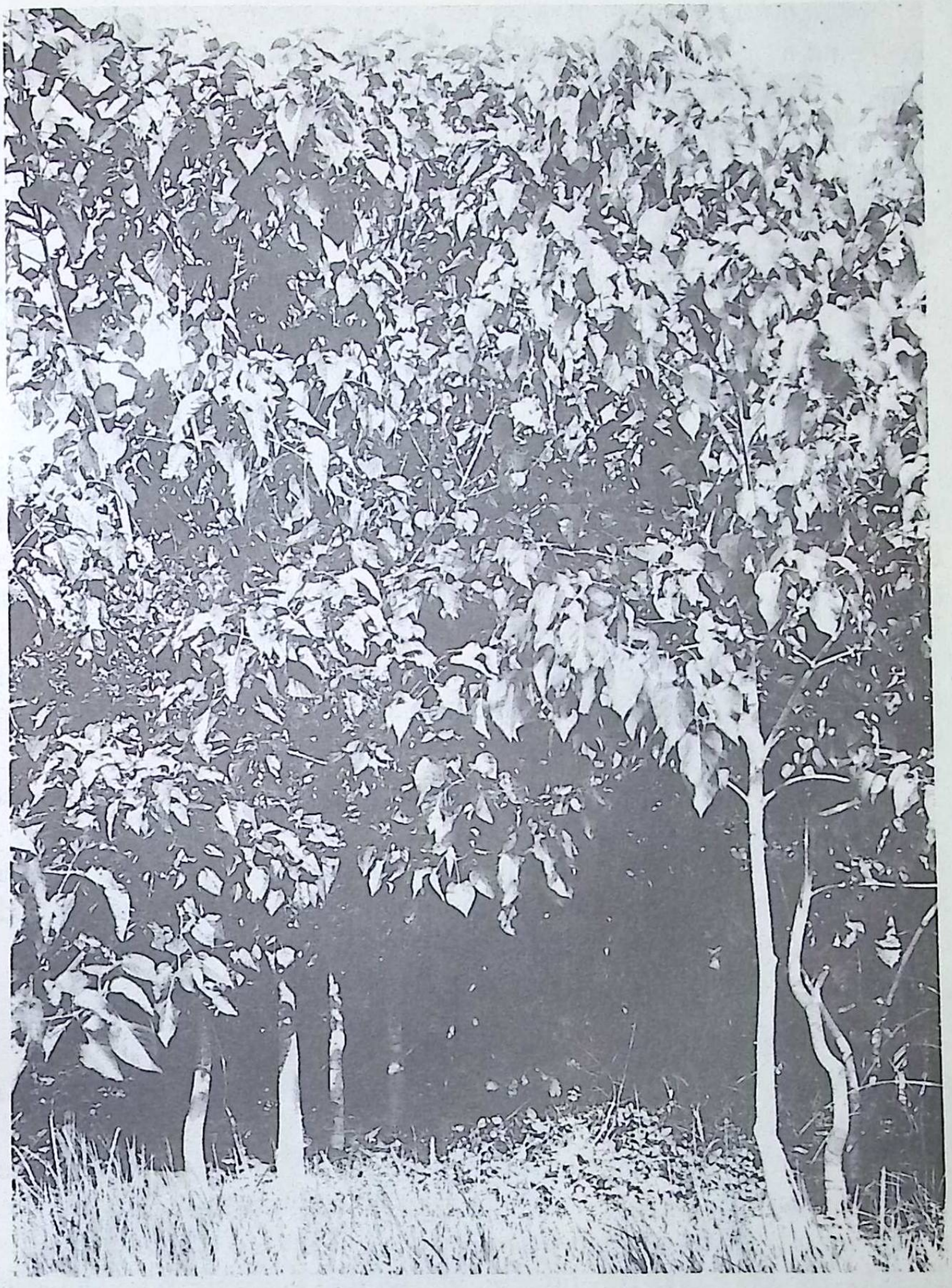
Beng–*Gumbar;* Hindi–*Gambhar;* Guj & Mar–*Shewan;* Kan–*Shivani;* Mal–*Kumbil;* Oriya & Sans–*Gambhari;* Tam–*Kumadi;* Tel–*Gumarteeku.*

Assam–*Gomari;* Madhya Pradesh & Punjab–*Kumher;* TRADE–*Gumhar.*

Habit—A moderate to large, deciduous tree, up to 30 m/1.2–4.5 m. *Stem*—clear bole of 9–15 m. *Bark*—smooth, whitish-grey, corky, exfoliating in patches when old. *Leaf*—opposite, broadly ovate, but usually cordate, glandular. *Flower*—brownish-yellow, in terminal panicles; February–April. *Fruit*—fleshy, ovoid or oblong drupe, yellow when ripe, with leathery, shining, pericarp and sweetish pulp, embedded with 2–3 stones; April–July. *Seed*—1300–2600/kg; germination 10–21 days, 13–100%, fresh being the best; viable up to 1 year; needs soaking; dispersed by cattle and deer.

Distribution and Ecology—Throughout the greater part of India; up to 1500 m; also planted in gardens and avenues. Largest dimensions are reached in mixed forests of moist regions, but extends into comparatively dry regions; also found in evergreen or even *sal* forests. Though grows on a very wide localities, it prefers moist, fertile valleys with 750–4500 mm rainfall; does not thrive on ill-drained soils and remains stunted on dry, sandy or poor soils; drought also reduces it to a shrubby form.

Silvicultural Characters—A light-demander, though tolerates shade. Intolerant of excessive drought, but moderately frost-hardy; has good power of recovery when injured by frost. Coppices very well with vigorous growth. Saplings and young plants need protection from deer and cattle.



Gmelina arborea

Cultivation/Regeneration

Natural Regeneration—Fruit falls during rainy season; heat and moisture stimulate the germination; but not plentiful inspite of high germinative power.

Artificial Regeneration—Can be procured through direct sowing or transplanting. Seed sown in lines at 3.0–3.6 m × 30 cm and thinned if necessary in the third year; dibbling or broadcasting also gives satisfactory results. For transplanting, fresh stones should be sown in nurserybed, regularly watered and weeded. Seedlings of 10–15 cm are transplanted in the first rains at 1.8 m asunder; if transplanted in the second rains, they should be pricked out during the first rains, and before transplanting roots and stems are pruned. Thinned or gap-filled, if necessary. Weeding and hoeing are essential in the first year. Cuttings also strike root well. Growth is fast.

UTILIZATION

Reclamation—Recommended for skeletal soils in medium rainfall areas; also recommended for block-planting on hills, field-boundaries, gullies and ravines, grassy blanks and for agro- and social forestry; clear grounds, particularly broken ones are favourable beds. Intercropping with food-crops reported to increase nitrogen and phosphorus in soil.

Timber—Furniture, musical instruments; slateframes, venetian-blinds, frames, artificial limbs, parts of loams and carts, bobbins, bridges, shipbuilding, plywood, match-industry; and paper-making.

Fodder—Leaf considered good for cattle (crude protein, 11.9%); also used as a feed for *eri*-silkworm.

Others—Bark & Root: Stomachic, galactagogue. *Leaf:* Applied to relieve headache; juice used as wash for ulcers. *Flower:* Given in blood-diseases. *Fruit:* Sweetish, bitter, cooling; given in bilious affections.

GREVILLEA R.Br. (*Proteaceae*)

Trees or shrubs; native to Australia; 2 spp in India.

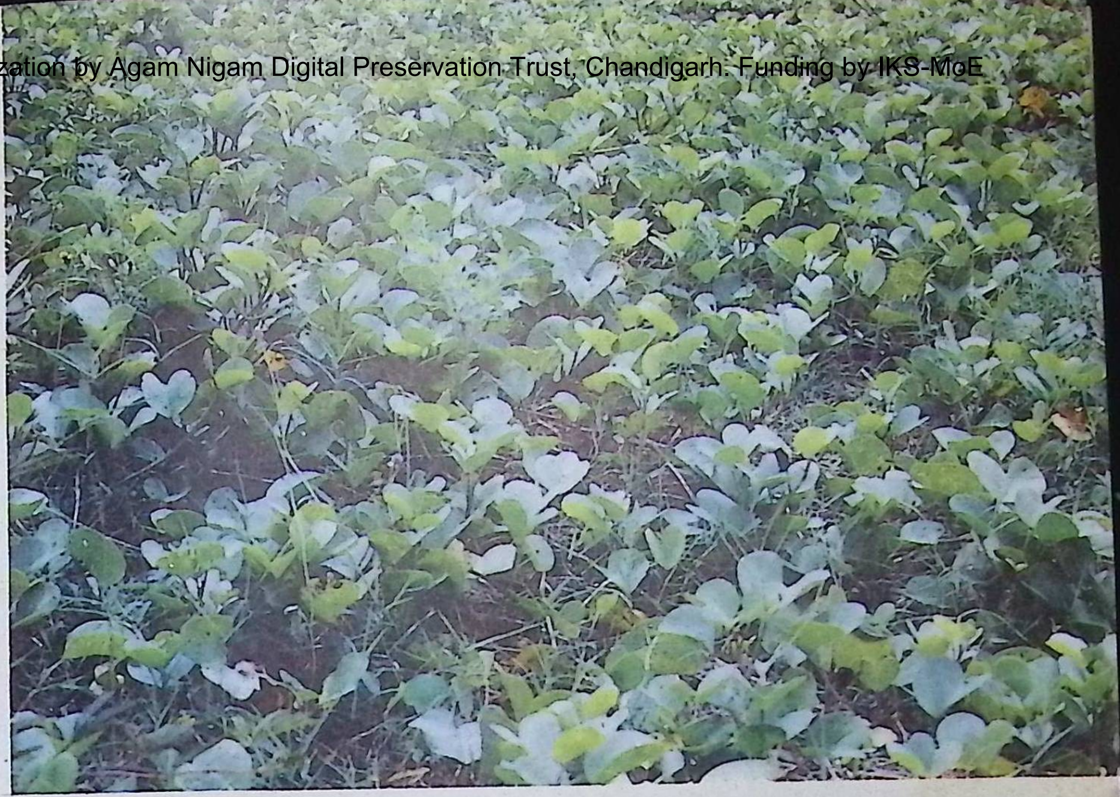
G. robusta A Cunn. SILVERY OR SILKY OAK

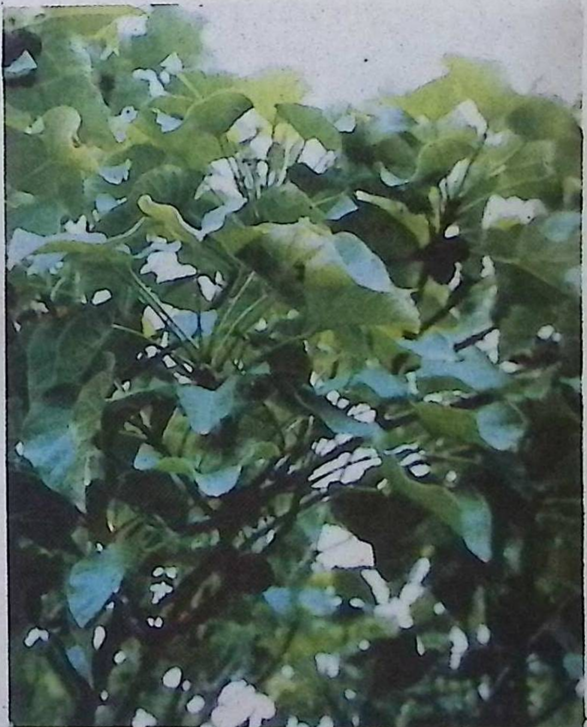
Tam–*Savukkumaram*.

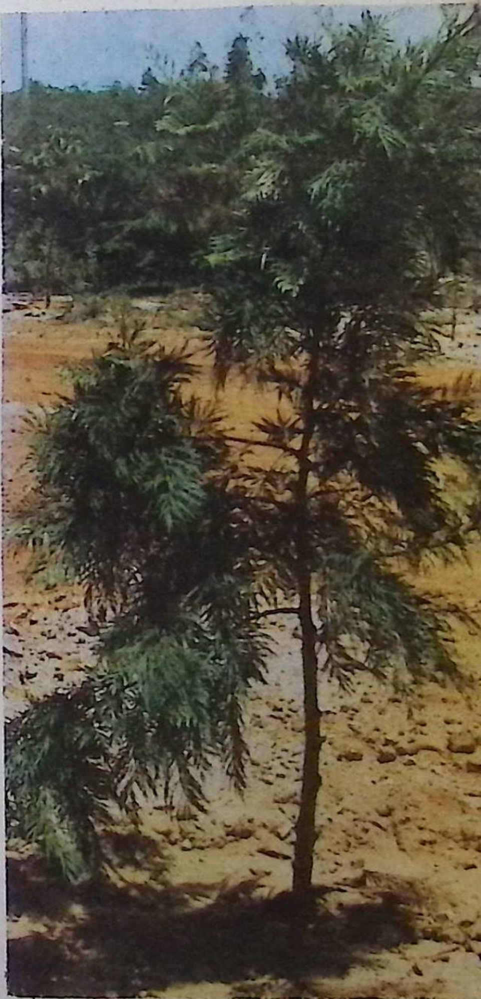
Habit—An evergreen tree, up to *c* 50 m. *Leaf*—alternate, fern-like, deeply pinnatified. *Flower*—orange-coloured, solitary or several together in racemes. *Fruit*—oblique, coriaceous, 1–2-seeded, follicle. *Seed*—100,000–105,600/kg; May–June; germination 21 days, 30–80%; viable up to 2 years; needs stratification.

Distribution and Ecology—Grown throughout India at elevations of 600–1800 m. Resistant to drought and frost, but should not be grown in situations exposed to high winds.

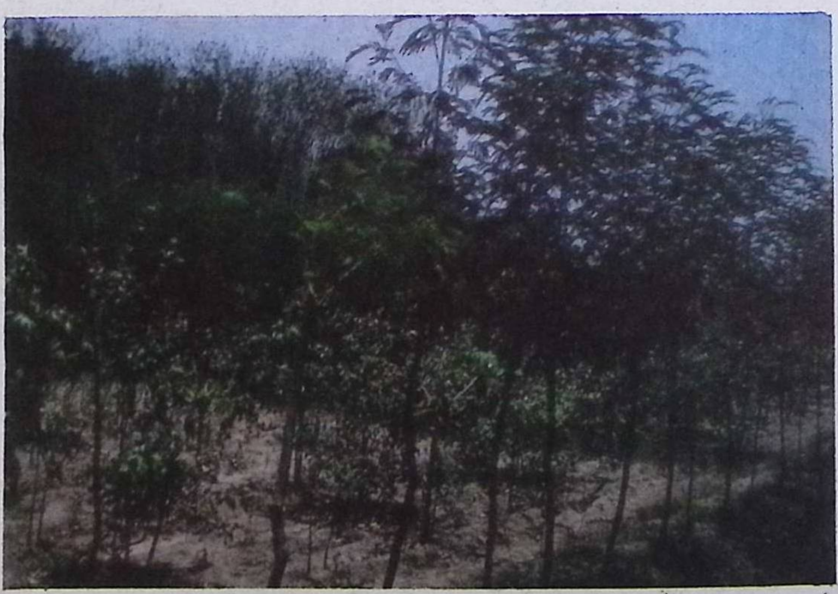
Cultivation/Regeneration—Seed can be sown direct during November–December or seedlings can be transplanted during July.


Ipomoea pes-caprae


Jatropha curcas


Grevillea robusta

Leucaena latisiliqua on tank-shore



L. latisiliqua in the foreground as shelterbelt and windbreak

UTILIZATION

Reclamation—Recommended for skeletal, laterite soils, hillsides in moist and very moist areas and grassy blanks; also for block-planting on hills and *terai* and *babhar* zones; agro- and social forestry; suitable for mined areas shelterbelts, hedge, and windbreaks. Grown as shade-tree for tea and coffee and commonly planted in gardens and avenues.

Timber—Ornamental with silvergrain. Panels and parquet-floor, furniture, staves for casks and cooperage, toys, cabinet-work, plywood, veneering; and paper-pulp.

Fuel—Moderately good firewood (sapwood, 4904 kcal; heartwood, 4914 kcal/kg).

Others—Bark: Yields a yellow gum. *Leaf:* Valued as green manure for coffee and tea. *Flower:* Source of nectar for honeybees.

**G. pteridifolia* Knight syn. *G. banksii* R. Br. is a fast-growing, hardy, small tree, 5–6 m, with pinnate leaves, bright coral-red flowers in one-sided racemes (December–January), and oblique, coriaceous, 1–2-seeded fruits, (25,000–30,000/ kg; February–April; germination 25–30 days, 70–80%), successfully introduced into Madhya Pradesh from Australia. Naturally regenerates on bauxite-mined areas and coal-mined overburdens, and is very successful.

HAPLOPHRAGMA Dop (*Bignoniaceae*)

Trees; South-East Asia to Indonesia; 1 sp in India.

H. adenophyllum (Wall. ex G.Don) Dop syn. *Heterophragma adenophyllum* Seem.

Andamans–*Petthan;* Assam–*Dhopa-paruli, ziron;* Lushai–*Mostanphul;* TRADE–*Karenwood.*

Habit—A handsome tree, 9–15 m. *Bark*—grey, deeply furrowed in large trees, 1.25 cm thick. *Leaf*—imparipinnate, 30–90 cm long: leaflets 2–3 pairs, with a big, terminal leaflet, variable, first pair very small, progressively increasing in size, 2.5–30.0 cm × 2.0–20.0 cm, elliptic or oblong, glabrous above, rusty pubescent beneath. *Flower*—large, yellowish-brown, in dense, terminal, tomentose panicles. *Fruit*—cylindric, elongated, twisted capsule, up to 90 cm long; cold weather. *Seed*—compressed, with a membranous wing on each side, 2.5 cm × 1.25 cm.

Distribution—Found in Assam and the Andamans; cultivated in gardens and planted in avenues.

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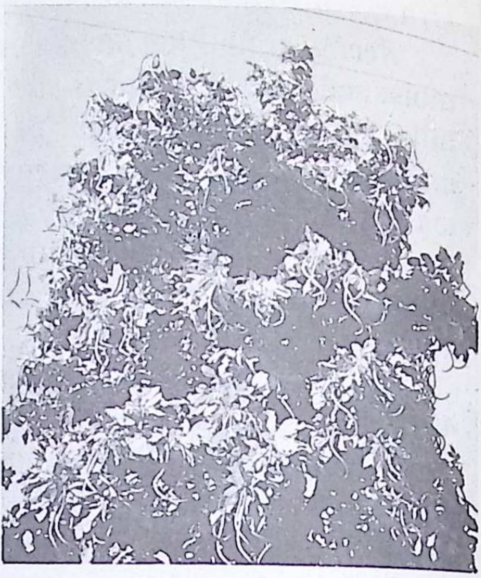
* Probably two independent species; the former is perhaps the synonym of *G. chrysodendron* R.Br.

Grevillea robusta



Haplophragma adenophyllum

UTILIZATION

Reclamation—Recommended for saline, alkaline, semi-arid soils, gullies and ravines; also for social forestry.

Timber—Furniture, cabinetwork, mouldings, aeroplane work, piles, shafts, carts and carriages.

HETEROPOGON Pers. (*Poaceae*)

Annual or perennial grasses; tropical, subtropical and temperate regions; 6 spp in India.

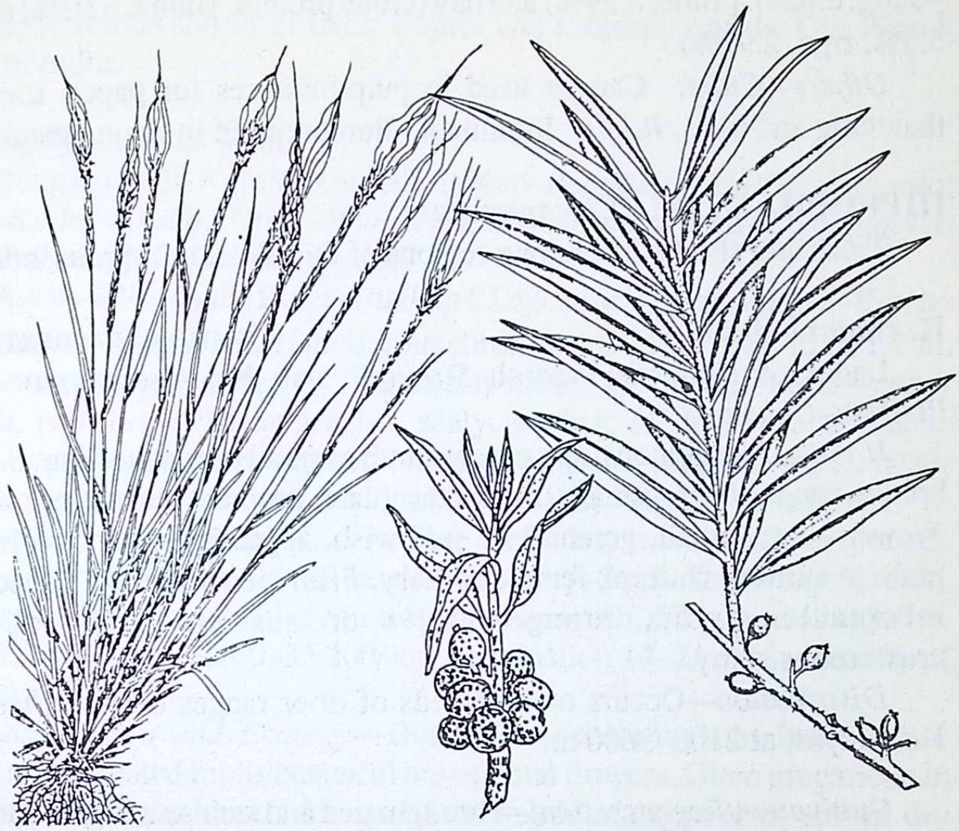
H. contortus (Linn.) Beauv. ex Roem. & Schult. syn. *Andropogon contortus* Linn. BELLARY-GRASS, SPEARGRASS

Beng & Hindi–*Kher;* Guj–*Dabhjuliyun;* Kan–*Karivunugadahullu;* Mar–*Gangtegawta, sunkhali;* Oriya–*Dauria;* Tam–*Karunsipullu, oosipullu;* Tel–*Eddugaddi, kaserigaddi.*

Punjab–*Sarwala.*

Habit—A densely tufted, gregarious, perennial grass, up to 1.5 m. *Culm*—erect, tufted, terete, simple, geniculately ascending. *Leaf*—narrow, linear, up to 60 cm long. *Flower*—sessile. *Spikelet*—terete, awned; August–December. *Fruit*—baibed, pungent, caryopsis; October–January. *Seed*—cylindric.

Distribution and Ecology—Throughout India, up to 2100 m, chiefly in dry places. A dominant component of the open grasslands in a variety of



Heteropogon contortus Hippophaë rhamnoides H. salicifolia

habitats, except aquatic; grows on a wide variety of soils and becomes dominant on poor, rocky and inhospitable lands. Extremely drought-resistant and hardy.

Cultivation/Regeneration—Grown from seed (5.5–6.6 kg/ha) and also rootstock (6000–7000/ha). Profusely tillers and high yield of grass can be obtained from numerous cuttings.

UTILIZATION

Reclamation—Tenaciously withstands repeated grazings, cuttings and even burning; its ability to survive even after ploughing makes it an ideal grass for cover and pasture to reclaim a wide variety of soils including poor, rocky and inhospitable lands, saline, alkaline and upper piedmont plains of Rajasthan and hilly regions.

Fodder—A chief pasture-grass on the hills of North India and also in parts of Karnataka and a fairly good fodder (crude protein: young, 7.5%; preflowering, 4.40%; flowering, 2.25%); awn-removed grass can be used at a later stage also. Can be converted into an excellent silage (crude protein:

young, 6.62%; prime, 6.59%) and hay (crude protein: young, 6.97%; prime, 5.3%; ripe, 2.97%).

Others—Culm: Can be used in pulp-mixtures for paper; used for thatching and mats. *Roots:* Stimulant, diuretic; used in rheumatism.

HIPPOPHAË Linn. *(Elaeagnaceae)*

Trees and shrubs; temperate regions of Old World: 2 spp in India.

H. rhamnoides Linn. COMMON SEABUCKTHORN

Ladakh & Himachal Pradesh–*Sirma;* Punjab–*Kalabisa*, *serma;* Uttar Pradesh–*Chuma.*

Habit—A deciduous, spinescent shrub or small tree, up to 12m. *Bark*—brown, rough. *Leaf*—small, linear-lanceolate, covered with silvery scales. *Flower*—very small, greenish or yellowish, appearing with new leaves: male in axillary clusters; female solitary. *Fruit*—enclosed by a succulent receptacle, ovoid, orange-yellow or scarlet. *Seed*—oblong, crustaceous,shiny.

Distribution—Occurs on riverbeds of drier ranges of North-western Himalayas, at 2100–3600 m.

Cultivation/Regeneration—Through seed and stem-cuttings. Produces abundant suckers.

UTILIZATION

Reclamation—Successfully grows on eroded clay-loams and bare gullies; tolerates arid, saline, alkaline and sandy calcareous soils. Suitable for checking sheet- and gully-erosion; also recommended for afforestation of coalspoils and industrial wastes, and slopes. Merits as a nitrogen-fixer. Improves soil.

Fuel—Good firewood; also converted into charcoal.

Others—Shrub: Extracts used in cosmetics, massage-cream and sun-burn-preventing preparations. *Bark:* Yields an oil (3.06%). *Twig & Leaf:* Yield tannins (4.5%) and ascorbic acid (340.8 mg/100 g). *Fruit:* Acidic; a rich source of vitamin-C; even powder retains vitamin-C. Stable food-stuffs, such as jelly and marmalade, can be made. Contains large quantities of carotene; also vitamin-B. Yields a pleasant red, fatty oil (0.2%). *Seed:* Yields a semi-drying oil (12.13%).

H. salicifolia D. Don, a willow-like shrub, found throughout the temperate Himalayas, has some uses including nitrogen-fixing.

HOLARRHENA R. Br. (*Apocynaceae*)

Laticiferous shrubs or trees; tropics and subtropics of the Old World; 1 sp in India.

H. antidysenterica Wall.

Beng & Hindi–*Kurchi;* Guj–*Kari;* Kan–*Beppale;* Mal–*Kodagapaala;* Mar–*Kodaga,kuda;* Oriya–*Pitakorwa;* Sans–*Kutaja;* Tam–*Kodagapalei;* Tel–*Paalakodasa, vishaakupaala.*

Assam–*Dhutkhuri;* Bihar–*Dudhiari;* Lepcha–*Fajeerip;* Punjab–*Kewar.*

Habit—A deciduous, laticiferous shrub or small tree, up to 12 m/1.2 m. *Stem*—moderately straight, cylindrical, clear, up to 6m. *Bark*—rather rough, pale brownish or greyish, scaly, peeling off in irregular flakes. *Leaf*—opposite, subsessile, membranous. *Flower*—fragrant, white, beautiful in profusion, in terminal corymbs; April–November, in 2 flushes. *Fruit*—cylindric, divaricate follicles, usually white-spotted, 15–45 cm × 5–15 mm, 25–30-seeded; February–April. *Seed*—light brown, linear, 8–20mm long, with a coma of pale-brownish, silky, spreading hairs, 2.5–5.0 cm long; 23,760–35,200/ kg; germination 14–21 days; viability of fresh seeds high.

Distribution and Ecology—Occurs almost throughout India, up to 1200 m; cultivated for its beautiful ornamental flowers. Often gregarious in *sal* and mixed deciduous forests of the sub-Himalayan tract and in dry *babhar* tracts, with a rainfall of 750–3750 mm, and on open wastelands.

CULTIVATION/REGENERATION

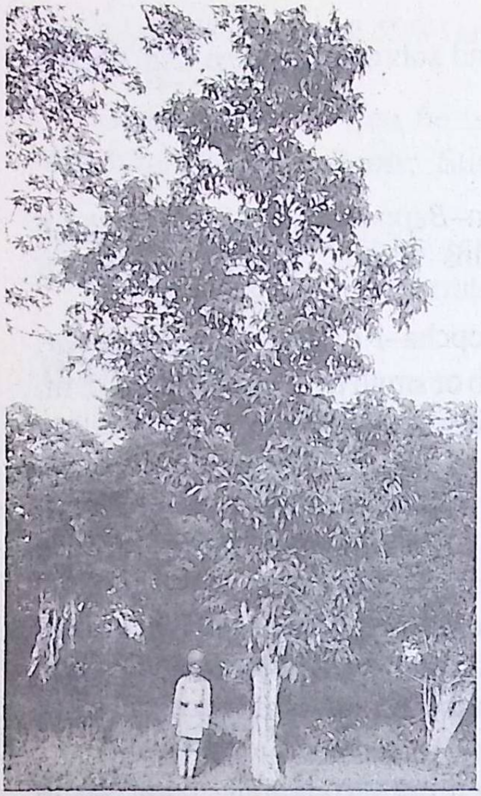
Natural Regeneration—Abundant owing to regular and copious seedlings from early age, comparative immunity from grazing and the power of recovery from all kinds of injuries. Seed germinates during the early rains. Weeding and watering stimulate growth. From second year onward growth is rapid. Commonly appears in open grasslands.

Artificial Regeneration—Both by direct sowing and transplanting; successfully grown with field-crops with 60 cm wide strip on both sides; weeding, periodic thinning and hoeing are beneficial. For transplanting, seed should be sown in nursery in March or early April; ready for transplanting in the next rainy season.

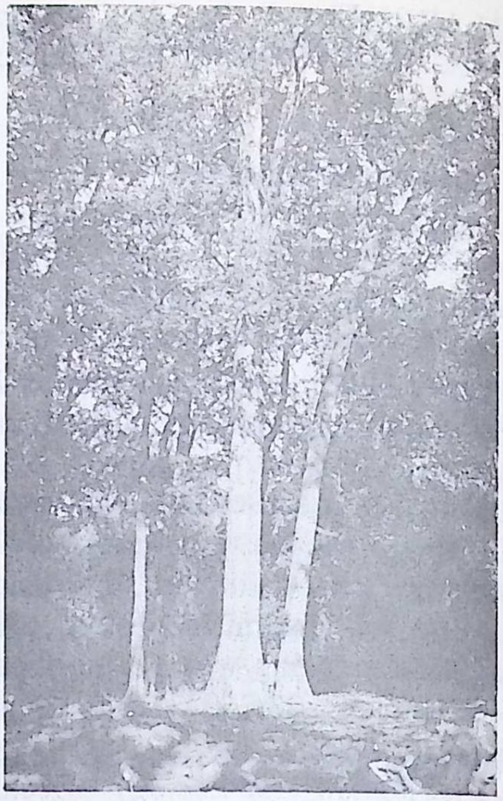
UTILIZATION

Reclamation—Important plant for reclothing wastelands. One of the first to appear and is the last to disappear in denuded forests; acts as a nurse-crop to *sal* and others.

Timber—Combs, spools, picture- and slateframes; mathematical in-



Holarrhena antidysenterica



Holoptelea integrifolia

struments, toys, carved boxes, cotlegs, paper-knives, walking-sticks, ploughs; and brushbacks. Ash rich in potash and used for dyeing; also used to open abscesses.

Others—Stem & Rootbark: Astringent, antidysenteric, anthelmintic, stomachic and antitubercular; used in amoebic dysentery and diarrhoea. *Leaf:* Used in dysentery, chronic bronchitis, boils and ulcers. Yields a dye similar to indigo; used as *bidi*-wrapper. Powdered leaf and root given to stop haemorrhage after childbirth and nosebleeding. *Flower:* Eaten. Employed in blood-diseases. *Seed:* Used as bark; given to promote conception. Yields an oil (19.3%). *Floss:* Employed for stuffing pillows.

HOLOPTELEA Planch. (*Ulmaceae)*

Trees; tropical and subtropical parts of Asia and Africa; 1 sp in India.

H. integrifolia Planch. INDIAN ELM

Guj–*Khanjho;* Hindi & Kumaun–*Kanju;* Kan–*Thavasai;* Mal–*Aval;* Oriya–*Dauranja;* Sans–*Chirabilva;* Tam–*Ayal;* Tel–*Thapasi.*

Madhya Pradesh–*Karanjalam;* Punjab–*Rajain;* TRADE–*Indian Elm, kanju.*

Habit—A small to very large, deciduous tree, emitting unpleasant odour on cutting, 15 m or more/ up to 3.6 m. *Rootsystem*—strong and spreading. *Stem*—clear bole of 6 m, with ascending or spreading branches. *Bark*—grey, fairly smooth, pustular, exfoliating in somewhat corky, scales. *Leaf*—elliptic-ovate, 5–13 cm long, acuminate, entire, sub-coriaceous. *Flower*—greenish-yellow, hermaphrodite or polygamous, in numerous short racemes or fascicles on the leafless branches; February–April. *Fruit*—suborbicular samara, with membranous wing; April–May. *Seed*—flat; 9000–32,400/ kg; germination 10 days, 60%; viable up to 6 months.

Distribution and Ecology—Throughout the greater part, up to 600 m; wild in waste places. Thrives well in deep, porous soils with good drainage but becomes stunted and crooked on poor, shallow soil; found in profusion on dry, stony *babhar* soils, on the rocky debris.

Silvicultural Characters—A moderate light-demander. Thrives without much moisture in the soil, provided deep and porous; requires good drainage. Not frost-hardy. Moderate coppicer. Not readily browsed.

CULTIVATION/REGENERATION

Natural Regeneration—Seed is dispersed by wind and germinates during the rainy season and survives if covered. In the sub-Himalayan tract, natural reproduction springs up in great profusion among the rocky debris in lower slopes of the outer hills and on the dry, stony, porous grounds along their base.

Artificial Regeneration—Direct sowing of fresh seed in the rains and transplanting nursery-raised seedlings. Beds should be loosened and weeded and irrigated in the nurseries; sometimes nurseries are shaded from heat until rainy season. Stump can also be planted.

UTILIZATION

Reclamation—Can be grown in the rocky debris in the Himalayas; recommended to reclaim skeletal soils, deep sandy soils, brackish lands, and gullies and ravines; also recommended for block-planting and in social forestry.

Timber—Brushbacks, handles, house-construction, boats, furniture, carts, mathematical instruments, shoeheels, cotton-reels, bobbins, plywood, match-boxes; and paper-pulp.

Fuel—A very good firewood (sapwood, 5258 kcal/kg); can be converted into charcoal.

Fodder—Leaf (crude protein, 13.7%) and fruit eaten by cattle, though not relished.

Others—Bark: Hardboards and insulation boards. Applied in rheumatism and skin-diseases. *Seed:* Yields an oil (37.4%) and a cake.

IPOMOEA Linn. (*Convolvulaceae*)

Twining, creeping, floating or erect herbs, rarely shrubs or trees; tropical and warm temperate regions; 60 spp in India.

Several species grow in hedges and on different kinds of wastelands, such as sandy coasts, riverbanks, ditches, canals and grasslands. Most of them need no inputs and much care. Some of these are used as green fodder and green manure. *I. batatas* (Linn.) Lam. (THE SWEETPOTATO), extensively cultivated on a wide variety of soils with a *p*H of 5.0–6.8, yields an important edible root-tuber; also grown on sandy riverbanks and riverbeds.

I. aquatica Forsk. syn. *I. repens* Poir. SWAMP-CABBAGE

Beng & Hindi–*Kalmisag;* Guj–*Nalanibhaji;* Mar–*Nadishaka*;Tam–*Vellaikeerai;* Tel–*Tuttikoora.*

Delhi–*Sarnali;* Punjab–*Ganthian.*

Habit—A very rapid-growing, aquatic, trailing or floating, herbaceous perennial or sometimes annual herb. *Stem*—long, hollow, rooting at nodes. *Leaf*—elliptic or ovate-oblong, cordate or hastate at base. *Flower*—infundibuliform, 2.5–5.0 m long, white or pale purple with a dark-purple eye, solitary or/5-flowered cymes. *Fruit*—ovoid, 8mm long, smooth, 2–4-seeded capsule. *Seed*—densely pubescent. *Flowering & Fruiting*—November–January.

Distribution and Ecology—Wild throughout India. Also cultivated on moist soils or mud, along the margins of stagnant streams, fresh-water ponds, ditches, marshes and wet paddy-fields; sometimes found floating on watersurfaces.

Cultivation/Regeneration—Rapidly grows from cuttings, producing dense mass of foliage within a few weeks of planting.

UTILIZATION

Reclamation—Suitable for reclamation of marshy lands. Useful as green manure for paddy.

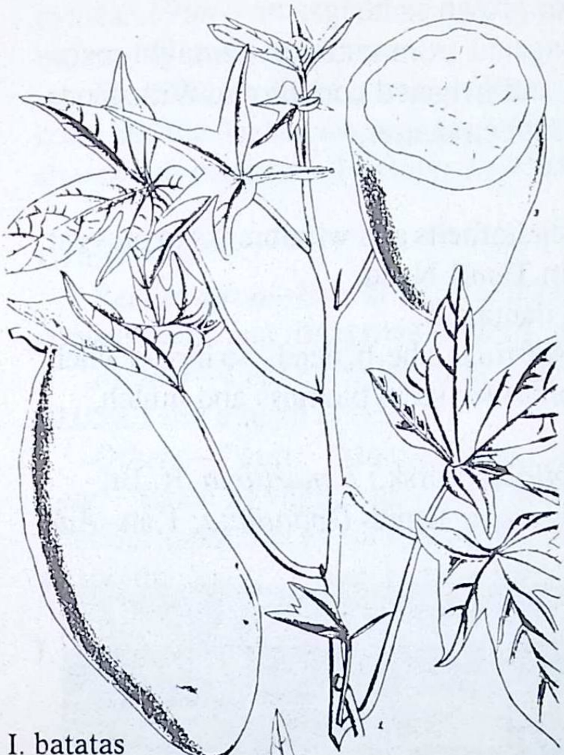
Fodder—Relished by cattle and pigs as green fodder (crude protein, 2.1%) and highly nutritious; used as a fish-food.

Others—Bud: Used in treating ringworms. *Shoot:* Young shoot and leaf (crude protein, 2.9%) used as vegetable and in salad; a good source of minerals and vitamin-A,-B,-C and -E. *Stem:* Suitable for paper-making.

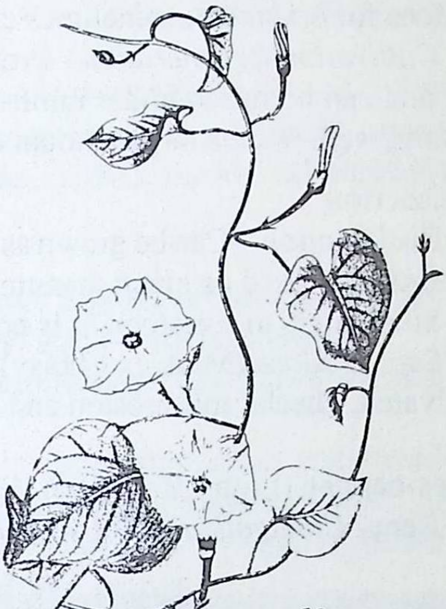
Leaf: Juice emetic and given in opium- and arsenic-poisoning; dried ones purgative and cooling.

I. carnea Jacq.

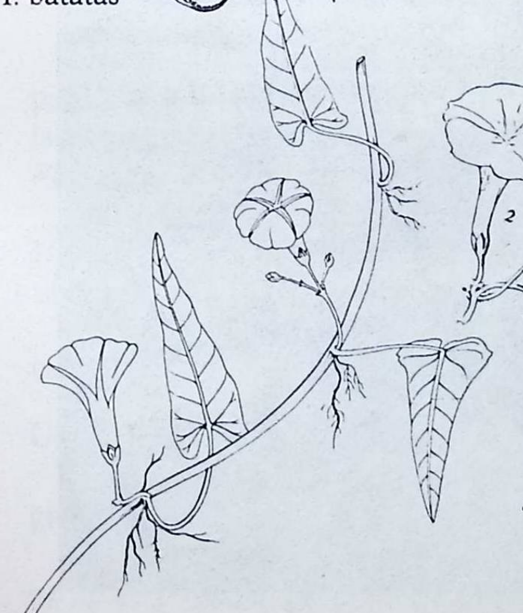
Habit—A large, diffuse or straggling shrub, with milky juice. *Leaf*—



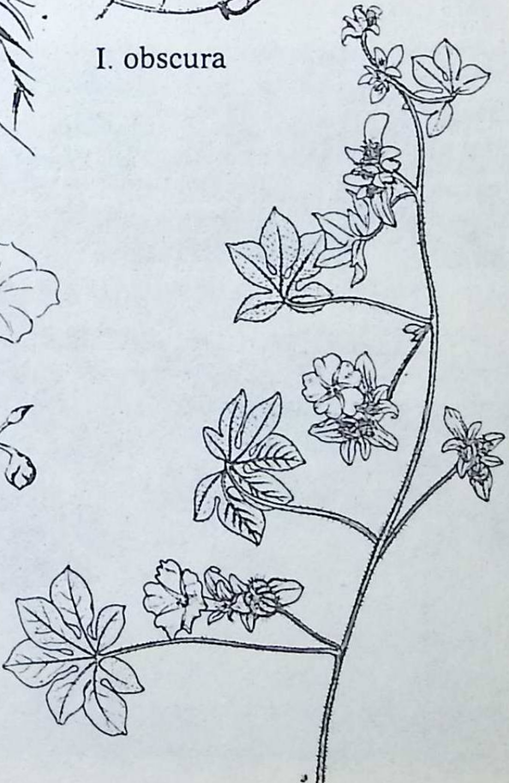
I. batatas



I. obscura



Ipomoea aquatica



I. pestigridis

ovate-cordate, entire, acuminate. *Flower*—large, campanulate, pale rose, pink or light violet, in lax, dichotomously branched axillary and terminal, pedunculate cymes. *Fruit*—glabrous capsule 1.27 m long. *Seed*— silky. *Flowering & Fruiting*—Throughout the year except winter.

Distribution—Native to South America, introduced and grown in many gardens for ornament; sometimes also grown as hedge.

Cultivation/Regeneration—Propagated from cuttings. Drought-resistant and can be raised under rainfed and irrigated conditions. Withstands pruning well. Yields large amount of green matter.

UTILIZATION

Reclamation—Can be grown as shelterbelts and windbreaks to prevent soil-erosion. Used as green manure in Tamil Nadu.

Since toxic to livestock, it is not damaged.

Ssp. *fistulosa* (Mart. ex Choisy) Austin is a herb, needs no inputs when cultivated, checks soil-erosion and provides large biomass and mulch.

I. pes-caprae (Linn.) R. Br. syn. *I. biloba* Forsk.; *I. maritima* R. Br.

Beng–*Chhagalkuri;* Guj–*Marjadavela;* Hindi–*Dopatilata;* Kan–*Ad-*

I. pes-caprae

umbaballi; Mal–*Adumbuvalli;* Mar–*Maryadvel*; Oriya–*Kanchonaluota;* Tam–*Adambu;* Tel–*Balabanditeega, chevulapilliteega.*

Habit—An extensively climbing or trailing, perennial herb. *Root*—thick, long. *Leaf*—orbicular, deeply bilobed, fleshy. *Flower*—large, funnel-shaped, brilliant rose-purple, pink or violet, in axillary, pedunculate cymes. *Fruit*—small, ovoid, glabrous 4-seeded, capsule. *Seed*—dark brown, villously tomentose.

Distribution and Ecology—Found in the Sundarbans, on east and west coast and the Andamans; also grown in Pilani (Rajasthan). Usually on sandy shores and occasionally along riverbanks, ditches, canals and waysides.

UTILIZATION

Reclamation—Useful as a soil-binder and recommended for sands, coastal sands and mangrove regions; and also for social forestry.

Fodder—Leaf eaten by cattle, but milk tainted. Contains a volatile oil (0.05%) and a resin (7.3%).

Others—*Plant:* Mucilaginous, astringent, stomachic and laxative. *Leaf:* Eaten as vegetable. Useful in rheumatism, dropsy and colic; juice diuretic; applied as a poultice to boils. *Root:* Dried juice purgative. Contains a saponin. *Seed:* Given in stomachache and cramps.

I. pestigridis Linn.

Beng–*Langulilata;* Mal–*Pulichuvatu;* Oriya–*Bilaipadu;* Tam–*Pulichovali;* Tel–*Chikunuvvu.*

Delhi–*Ghiabati;* Madhya Pradesh–*Panch-patri.*

Habit—A spreading or twining, herbaceous annual. *Leaf*—deeply palmate, 5–9-lobed, hairy. *Flower*—funnel-shaped, white or pink, in axillary cymes. *Fruit*—ovoid, papery, glabrous capsule. *Seed*—minutely velvety. *Flowering & Fruiting*—September–December.

Distribution and Ecology—Almost throughout India, up to 1600 m. Usually grown in hedges, grasslands, bushes, fields, waste places and seacoast.

Cultivation/Regeneration—Easy to cultivate during monsoon; also can be cultivated with *Sorghum* for forage.

UTILIZATION

Reclamation—Can be grown in waste places and on seacoasts; remains green and succulent for 3–4 months.

Fodder—May be fed to livestock in green state (crude protein, 12–27%) or as hay (crude protein, 13.58%); and the nutritive value favourably compares with legumes.

Others—Leaf: Used as poultice to boils, pimples and sores. *Root:* Used as purgative.

I. learii Paxt., a native to South America, is a perennial climber, introduced into India and grown on walls and trellises. Useful as a cover for wastelands and embankments. Root used in dysentery.

I. obscura (Linn.)Ker-Gawl. (Guj–*Gumbadvel;* Mal–*Cherutali;* Mar–*Pilibonvari;* Tel–*Nallakokkita*) is a twining annual, with ovate leaves and funnel-shaped yellow or white flowers, found throughout India, up to 1200 m in hedges, grasslands and wastelands; leaf used in sores.

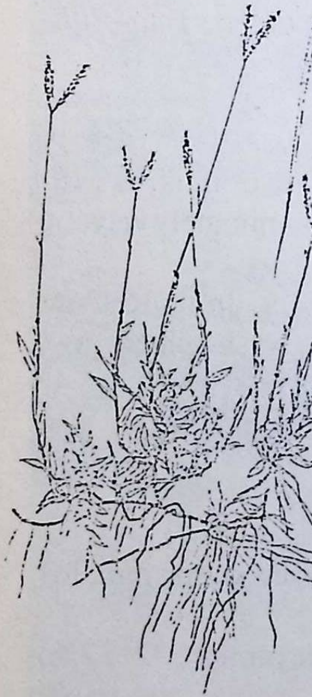
ISCHAEMUM Linn. (*Poaceae*)

Annual or perennial grasses; tropical, subtropical and warm-temperate regions; 30 spp in India.

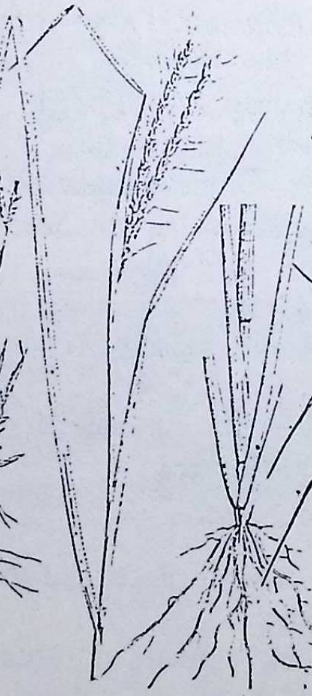
Many of these grasses are found on the banks or marshy places and useful as soil-binders; also grazed by livestock.

I. indicum (Houtt.) Merrill syn. *I.ciliare* Retz. is a prostrate or decumbent annual herb, rooting at nodes, with terete culms of 20–45 cm and linear-lanceolate, 1.5–3.5 cm × 0.25–0.4 cm leaves, found in Maharashtra. It is good soil-stabilizer.

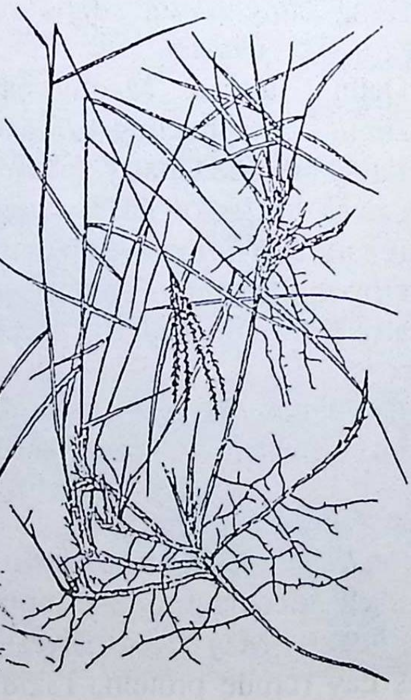
I. muticum Linn. is a low, rather coarse, extensively creeping, perennial grass, up to 60 cm, with a stout, vigorous rootstock and ovate to lanceolate leaves, gregariously found in Madhya Pradesh, Karnataka and Kerala.



Ischaemum indicum



I. rugosum



I. pilosum

Prefers marshes and coastal sands and saline soils, moist banks of streams and paddy-fields. A good sand-binder and useful for preventing erosion and stabilizing coastal sand-dunes, and for reclamation of banks and abandoned lands. Considered a good fodder (protein, 2.4%). Leaves applied as poultice for headache.

I. pilosum (Klein ex Willd.) Wight (Tel–*Kundaragaddi;* Bombay–*Dungri-kunda;* Madhya Pradesh–*Kari*) is a tall, erect perennial grass, 30-150 cm, with a stout, stoloniferous rootstock, having extensive rootsystem, found in Guntur and Ceded districts of Andhra Pradesh and in Madhya Pradesh, preferring black cotton-soils. Valuable in preventing erosion and reclamation of ravines, as it rapidly spreads and can regenerate from the smallest part of the rhizome. A desert-fodder, moderately relished by cattle (protein, 2.17%); also suitable for silage and hay.

I. rugosum Salisb. (Beng–*Moraro;* Tam–*Kadukhenpillu;* Assam–*Joyajha;* Bombay–*Bar;* Madhya Pradesh–*Badaul;* Punjab–*Mehat*; Rajasthan–*Jalgundya;* Santal–*Marudi;* Uttar Pradesh–*Dhanua*) is a tufted, erect annual, 30–90 cm, with flat, linear-lanceolate leaves and oblong grains, found throughout the greater part of India, up to 1800 m, and in the Andaman Islands. Prefers wet grasslands, marshy situations, shady areas and black soils; common weed in paddy-fields. Eaten by cattle (crude protein, 7.13%) and horses; grains sometimes used as food.

I. laxum R.Br.= *Sehima nervosum* (Rottb.) Stapf, found in Rajasthan and Deccan, and *I. sulcatum* Hack. = *Sehima sulcatum* (Hack.) A. Camus occur on the Deccan deserts and *I. tumidum* Stapf ex Bor on rocky soil along roadsides in South India and Maharashtra. *I. heterotrichum* Hack. is found growing on seashore of Nicobars, often forming mats in coconut plantations. *I. timorense* Kunth (Kan–*Nilamungahullu*) is distributed in damp, wayside places of plains and hills of India and is eaten by cattle. These may be useful in preventing erosion.

JATROPHA Linn. (*Euphorbiaceae*)

Herbs, shrubs and trees; tropical and subtropical world, chiefly in Africa and America; 9 spp in India.

Some are grown for ornament.

J. curcas Linn. PHYSICNUT, PURGINGNUT

Beng & Hindi–*Bagbherenda;* Guj–*Jamalgota;* Kan–*Adaluhavatu;* Mal–*Kattavanakka;* Mar–*Mogalierenda;* Oriya–*Jahaziagaba;* Sans–*Kananaeranda;* Tam–*Kadalamanakku;* Tel–*Peddaneepaalamu.*

Assam–*Bongalibhotora;* Garo–*Borbandong*.

Jatropha curcas–Crop

Habit—A rapid-growing shrub, up to 3–4 m. *Leaf*—alternate, 10–15 cm × 7.5–12.5 cm broadly ovate, usually palmately 3- or 5-lobed. *Flower*—yellowish-green, in loose panicles of cymes; July–August. *Fruit*—ovoid, black, *c* 2.5 cm long; October–December. *Seed*—ovoid-oblong, dull brownish-black; 2370/kg; germination, 70–100%.

Distribution and Ecology—Native to tropical America, occurring almost throughout India and in the Andamans; semi-wild conditions in the vicinity of villages. Hardy and withstands dry weather.

Cultivation/Regeneration—Seed or long cuttings.

UTILIZATION

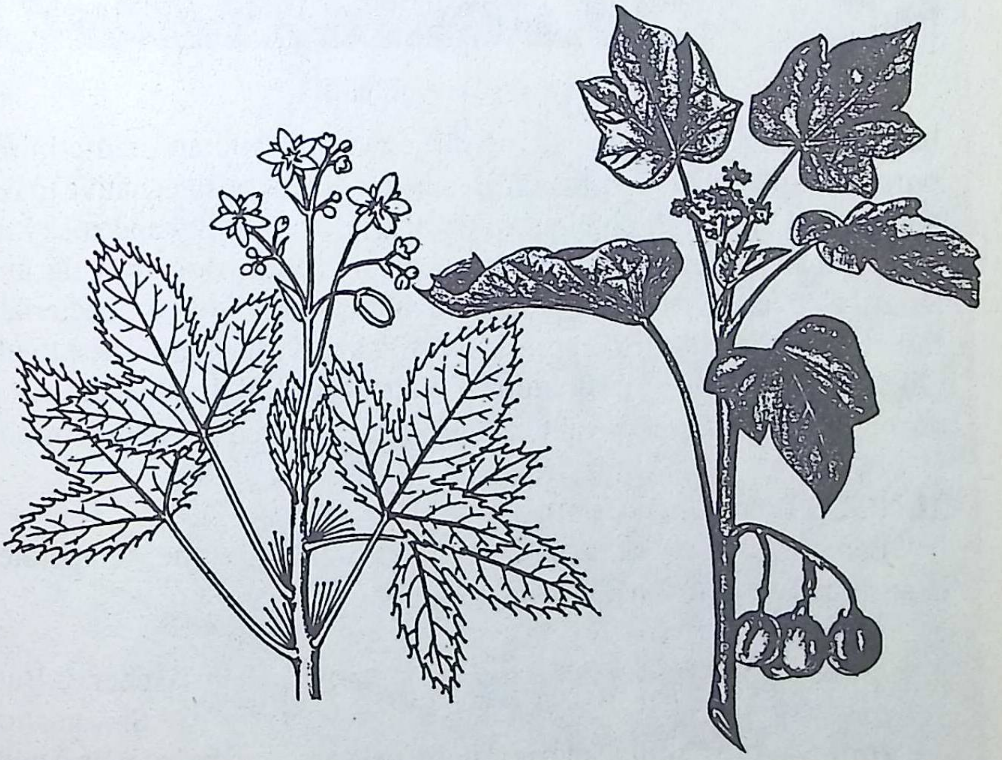
Reclamation—Planted to prevent water-erosion and for conservation. Recommended to grow as shelterbelts in controlling sand-drift; used as green manure. Rapid growth, withstanding the cutting or lopping and reluctance to browsing by cattle or goats make it more useful in conservation. Also planted as hedge.

Plant contains latex, which, on drying, resembles shellac; can be used for making ink. A prospective petrocrop which can be grown on wastelands.

Others—Bark: Yields tannins (37%). *Twig:* Young cooked and eaten; mature ones used for cleaning teeth. Juice purgative and styptic; relieves toothache and strengthens gums; applied in piles. *Leaf & Root:* Decoction given in diarrhoea. Yields a dye; used to give tan and brown shades. *Seed:* Possesses poisonous and purgative properties. Yields an oil (30–40%), suitable as fuel for diesel-engine; also useful as illuminant, lubricant and in soap- and candle-making. Externally applied in skin-diseases and rheumatism and sciatica. Cake unfit as feed but can be used as manure; protein can be a source for plastics and fibre.

J. glandulifera Roxb. (Hindi & Mar–*Janglierandia;* Kan–*Totlagida;* Mal–*Atala;* Tam–*Adalai;* Tel–*Dundigappu*) is an evergreen shrub, often confused with *J. gossypifolia*, commonly found on black cotton-soils in Andhra Pradesh southwards, particularly near the coast; can be grown to prevent erosion. Seed yields an oil (20–22%) and tannins; oil purgative and externally applied in rheumatism and paralytic affections; may be useful for soap-making. Protein from the cake may be useful for plastics and synthetic fibre. Gel from bark useful in skin-troubles. Root causes purging and reduces swellings.

J. gossypifolia Linn. (Beng–*Lalbherenda;* Hindi–*Bherenda;* Tam–*Atalai;* Tel–*Neelaamudam;* Assam–*Bhotera*) is a bushy, gregarious shrub, up to 1.8 m, with palmately 3–5-lobed, 20 cm long and wide leaves



J. glandulifera

J. curcas

J. gossypifolia

having a long petiole, covered with glandular hairs and red-crimson or purplish flowers in corymbs and greenish seeds in capsule, native to Brazil, naturalized almost throughout India in arid, semi-rocky and rocky areas; gregariously occurs in waste places; recommended for growing in such areas; also cultivated for ornament. Shoot possesses antibacterial and insecticidal activity; leaf applied in eczema and itches and latex to ulcers. Oil from seeds is used as illuminant. Extract of seed is active against pests during storage of grain. Root contains anticancer compound, jatrophine.

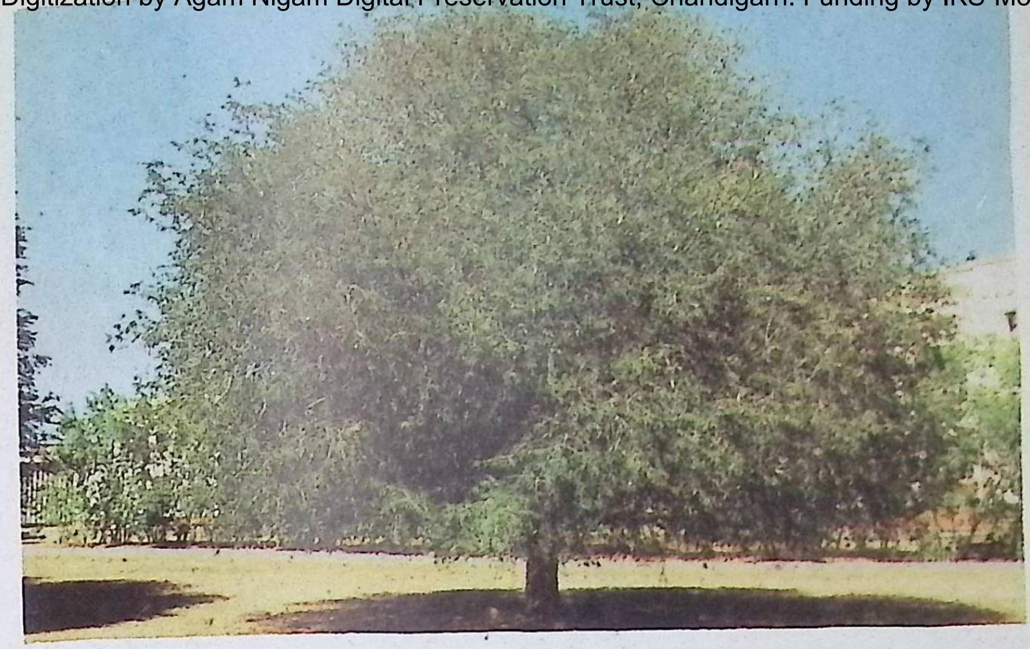
JUNCUS Linn. (*Juncaceae*)

Perennial, rarely annual herbs; called Rush; arctic, temperate and occasionally tropical regions; 22 spp in India.

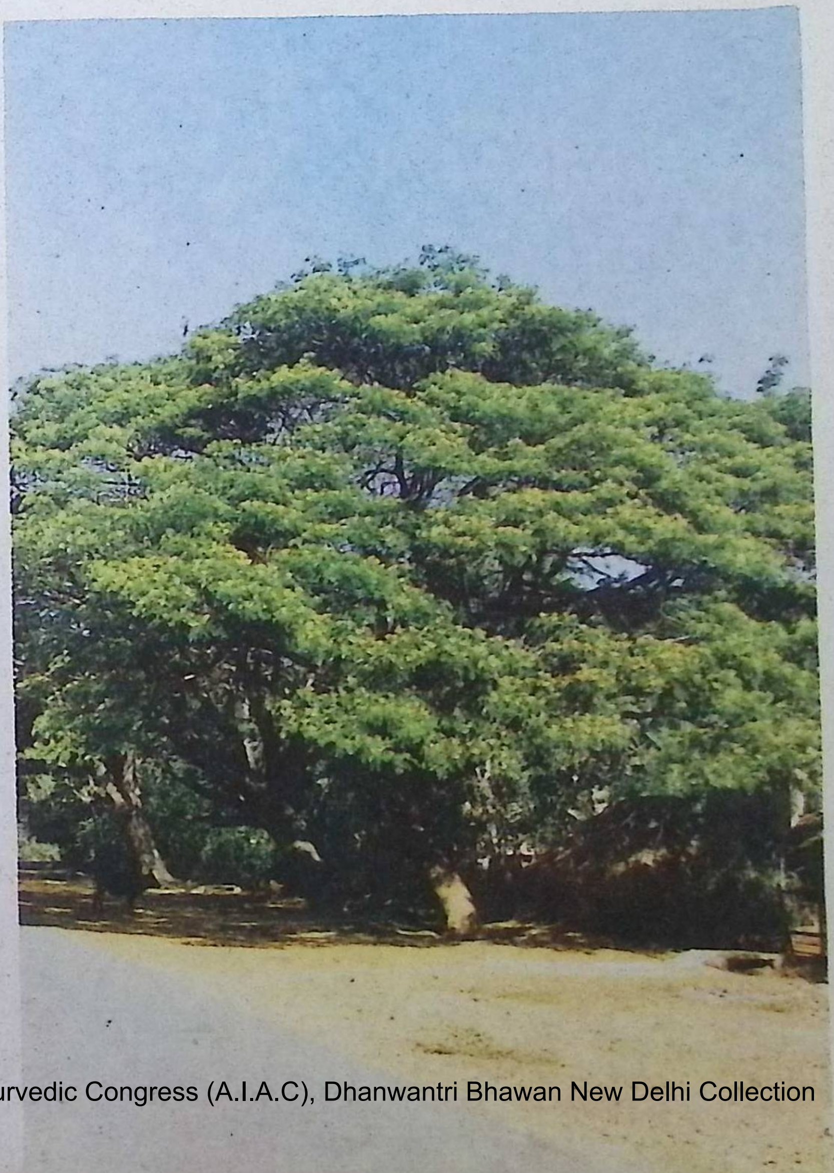
J. rigidus Desf. syn. *J. maritimus* Lam. var. *arabicus* Ascher.& Buch.

Sea-rushgrass

Habit—A stiff, tufted or caespitose, pale green, subglaucous perennial, 30–100 cm. *Rhizome*—Creeping. *Leaf*—near the base only, shorter, equal-



Tamarindus indica



Samanea saman

Lagerstroemia speciosa

Tamarix sp and *Saccharum* sp on salt-affected soils

ling or exceeding the stems, cylindric, sharply tipped with a continuous pith. *Flower*—straw-coloured, usually in groups of 2–3, in irregularly or fasciculately erect, compound inflorescence; throughout the year. *Fruit*—ovoid-trigonous, shortly beaked capsule, 2.5–5.0 mm long, brownish; throughout the year. *Seed*—many; germination very high at 20–26°C.

Distribution and Ecology—Found in extreme arid to semi-arid climatic conditions, marshy inlands or on saline coastal sand and sand-mixed silt. Grows on saline and alkaline soils, poor soils in sandy nature to medium black to black clayey soils. Found cultivated or often occurs wild in Gujarat.

Cultivation/Regeneration—Propagated from seeds and rhizomes. Seedlings develop rhizomes in 5–6 months and new culms arise. When vegetatively propagated, rhizomes are transplanted 5-10 cm deep at 1 m asunder under irrigated conditions. Culms are harvested at the end of second year and later once in six months.

UTILIZATION

Reclamation—Possesses high salt-tolerance and accumulates excessive salts in the aerial parts. Can be grown on saline soils for reclamation.

Others—Culm: Green ones used for a very high-quality paper-pulp. *Seed:* May be used as antidiarrhoic and diuretic.

J. articulatus Linn., found in Kashmir, and *J. gerardii* Loisel. are recommended for reclaiming saline soils. *J. effusus* Linn. (COMMON OR MATTING-RUSH) is a densely tufted, cylindrical and soft perennial, 30–90 cm high, with short leaves and greenish or brownish flowers and ovoid capsule, found in the Sikkim Himalayas, Aka hills and Khasi hills, at 1500–3000 m, and prefers wet and marshy situations; recommended for reclaiming saline soils. Used for mats, baskets and chair-bottoms. Leaf contains proteins (8.6%), but poisonous to cattle. *J. inflexus* Linn. syn. *J. glaucus* Ehrh. ex Sibth. (HARDRUSH) is a tufted, dark-green, perennial herb, 30–45 cm high, with cylindrical stem, usually found in damp situations from Kashmir to Nepal, Arunachal Pradesh and on the Nilgiri and Palni hills, at 1800–2700 m. Recommended for reclaiming the wet soils. May be useful for mats and baskets.

JUNIPERUS Linn. (*Pinaceae*)

Evergreen, aromatic shrubs or trees; chiefly in northern hemisphere from the arctic zone to the mountains of the tropics; 50 spp in India; a few have been introduced.

Generally ornamental, the wood of some species is suitable for pencils; a few medicinal. Bushy-habit species may be grown in hedges and the spreading ones are good for groundcover in semi-wild places; some are useful for reforestation. Well adapted to medium and high elevations, they prefer sunny situations. They thrive best in sandy and loamy, moderately moist soil; also grow well on rather dry, rocky and gravelly ground. Propagation is through seed, cuttings, layer or grafting. Seed retains the viability for long, if stored in cool, dry places. They often take a year to germinate, though at times germinate in a few weeks. Hot-water treatment for a few minutes improves germination.

J. communis Linn. COMMON JUNIPER

Beng–*Havusha;* Hindi–*Aaraar*; Mar–*Hosha.*

Delhi–*Abhal;* Kumaun–*Chichia;* Punjab & Kashmir–*Betar.*

Habit—A dense, more or less procumbent shrub, rarely a small tree. *Bark*—reddish-brown, peeling off in papery shreds. *Leaf*—linear-subulate, in whorls of 3, 5–15 cm long, sharply pointed, upper surface concave, glaucous, bluish-white, lower surface bluntly keeled. *Flower*—usually dioecious, axillary; March–April. *Fruit*—subglobose, bluish-black when ripe, covered with a waxy bloom, 10–12 mm in diam, 3-seeded; August–September of second year. *Seed*—elongated ovoid; 10,000/ kg; June–December; germination up to 70%; dispersed by birds.

Distribution and Ecology—On the Himalayas from Kumaun westwards, at an altitude of 1500–4200 m. Thrives on sandy and loamy, moderately moist soil, and also grows well on rather dry, rocky and gravelly ground.

UTILIZATION

Reclamation—Suitable to grow in cold deserts for reclamation of land.

Timber—Fencing; turnery, and veneer. Young wood and twig burnt as incense. Diuretic, sudorific and blood-purifier. Yields an essential oil (0.32%).

Fuel—Used as firewood.

Fodder—Exhausted fruits used as feed to stock (crude protein, 6.23%); also used as diuretic and sudorific.

Others—Bark: Used for tanning. *Leaf:* Contains volatile oil with woody, minty odour. *Root:* Yields a purple dye. *Fruit:* Eaten. Yields a brown dye and OIL-OF-JUNIPER; stimulant, diuretic and carminative and exhibits antifungal activity against certain skin-infecting fungi. Employed for flavouring gin, cordials, alcoholic beverages, and food products.

J. macropoda Boiss. HIMALAYAN PENCIL-CEDAR, INDIAN JUNIPER

Punjab–*Shur;* Uttar Pradesh–*Dhup, padam.*

Habit—A shrub or tree, 12–15 m/1.8–2.1m. *Bark*—reddish-brown, exfoliating in long, fibrous strips. *Leaf*—dimorphic: acicular on some lower branches, scale-like, closely appressed into others. *Flower* —male at the tips of branchlets; female terminating on side branchlets; February–March. *Fruit*—bluish-black, globose, resinous; September–October of next year. *Seed*—ovoid, 2–5 in each fruit; 53,000/ kg; germination 30–70%; good seed-years less frequent.

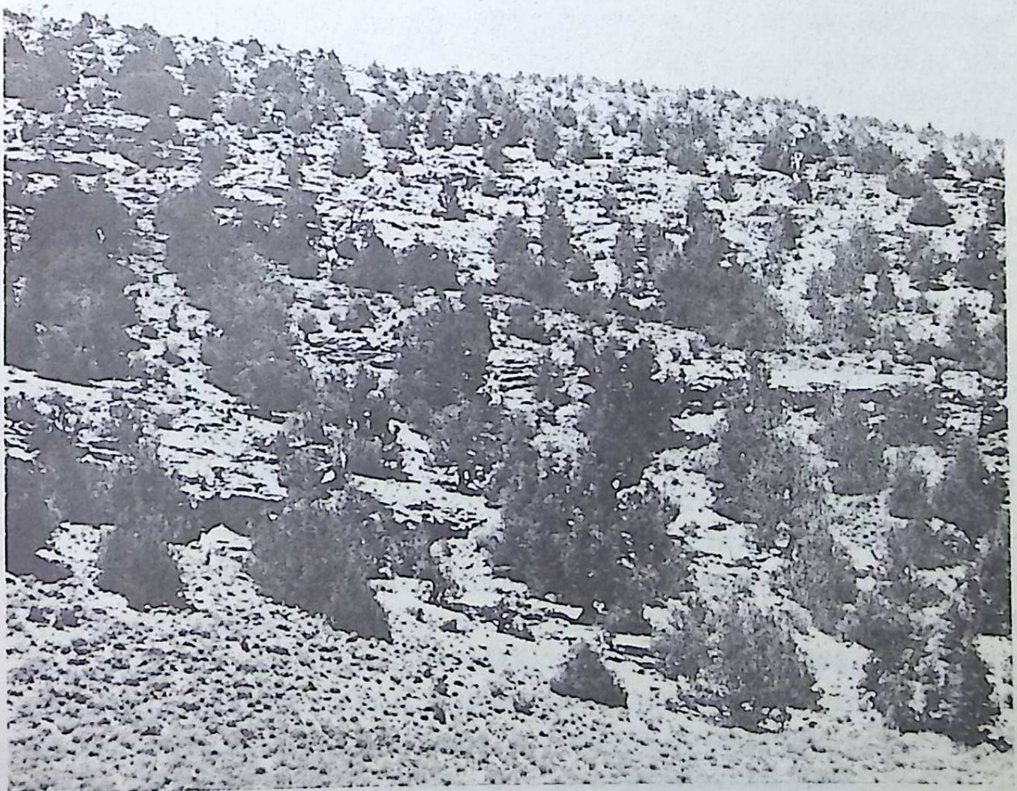
Distribution and Ecology—Inner ranges of the Himalayas at 1500–4200 m; sometimes cultivated in plains. More or less gregarious in open crops; also occurs scattered on dry, rocky or stony ground in scanty rainfall areas. Under favourable, sheltered situations with a moderate moisture in soil, the plant becomes dense; drought- and frost-hardy, enduring low temperatures.

CULTIVATION/REGENERATION

Natural Regeneration—Seedlings appear and perish, probably due to drought. Heavy snowfall assists reproduction.

UTILIZATION

Reclamation—Since the tree has a very strong rootsystem, it can be



Juniperus macropoda

used as windbreaks, particularly on dry, rocky grounds and for reclaiming the soils in low-temperature areas at high altitudes.

Timber—Chiefly used for pencils; also for house-building and walking-sticks.

Fuel—Used as firewood, and for charcoal.

Others—*Twig:* Burnt as incense; reported to relieve delirious conditions in fevers. *Fruit:* Employed as *J. communis*.

J. wallichiana Hook. f. syn. *J. pseudosabina* Hook. f. (Fl Br Ind), non Fisch. & Mey. (BLACK JUNIPER; Hindi–*Bhil*; Sikkim–*Tchokpo*) is a robust shrub or tree, up to 18 m, found in the Himalayas from Kashmir to Bhutan, at 2700–4500 m. Useful for reclaiming the cold deserts. Timber resembles that of *J. macropoda*. Twigs burnt as incense which acts as insect-repellant, and bark used as pads.

LANTANA Linn. (*Verbenaceae*)

Herbs, undershrubs or shrubs; mostly in tropical and subtropical America and a few in the tropics of Old World; 8spp in India.

L. camara Linn. var. **aculeata** Moldenke; syn. *L. aculeata* Linn.; *L. camara* auct., non Linn. LANTANA, WILDSAGE

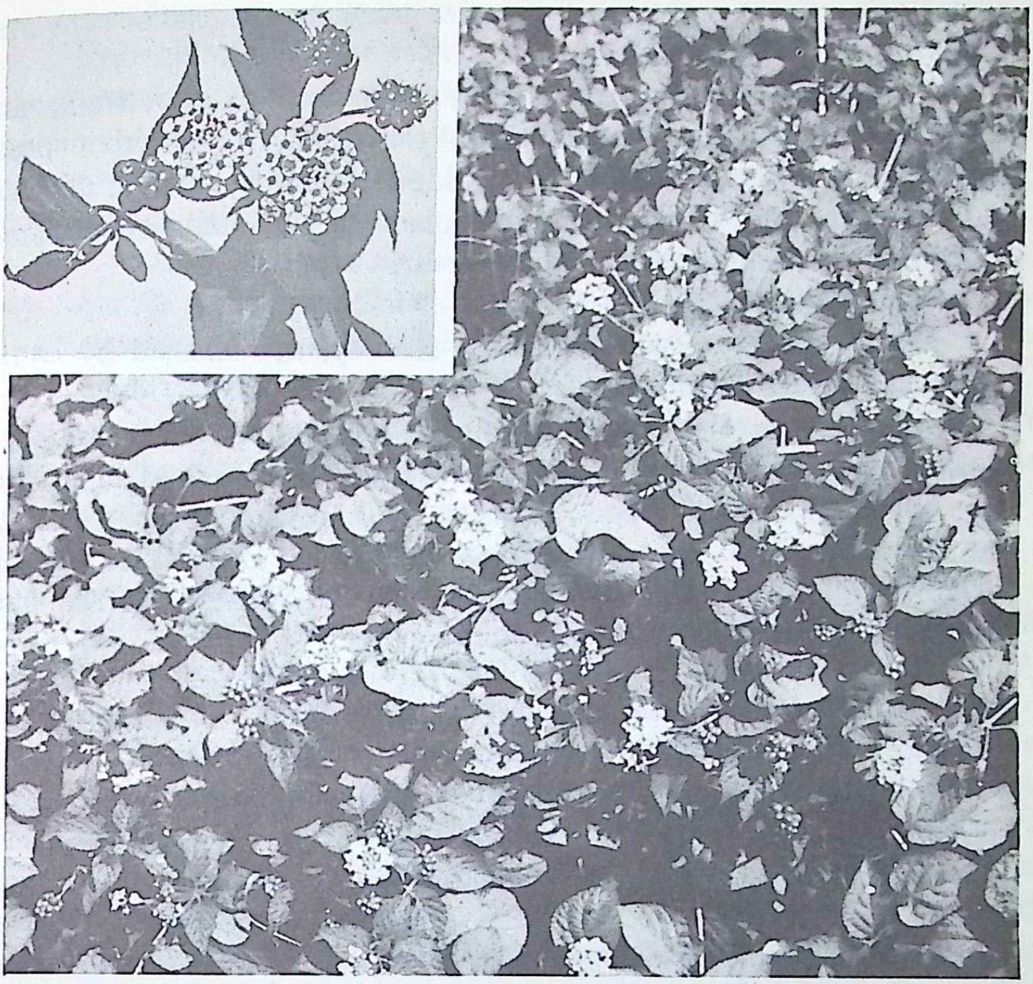
Kan–*Natahugide;* Mal–*Arippu;* Mar–*Chadurang;* Tam–*Unnichedi;* Tel–*Pulikampa.*

Madhya Pradesh–*Raimuniya.*

Habit—A low, erect or subscandent, vigorous shrub, with stout recurved prickles and a strong odour of black currents, 1.2–2.4 m. *Rootsystem*—very strong, gives out new flush of shoots even after repeated cuttings. *Leaf*—ovate or ovate-oblong, acute or subacute, crenate-serrate, rugose above, scabrid on both sides. *Flower*—small, usually orange, sometimes varying from white to red in various shades and having a yellow throat, in axillary heads; almost throughout the year. *Fruit*—small, greenish-blue black, blackish, drupaceous, shining, with two nutlets; almost throughout the year; dispersed by birds. *Seed*—germination very easy, high.

Occurrence of var. *camara* in India is doubtful, but 3 other varieties occur in India, var. *aculeata* being the commonest.

Distribution and Ecology—Introduced into India, ran very wild throughout India. Grows under varying conditions of climate and soils; thrives in very moist areas with more than 5000 mm rain and also in areas with 750 mm rain; found on several waste places including rocky areas, open plains, valleys, moist areas, on the hills up to 1800 m, and on any type of soil, rich or poor, including gravel and laterite. Drought-resistant, light-loving and tolerates moderate shade.



Lantana camara var. aculeata

Cultivation/Regeneration—Readily propagates from seed, stump or cutting. Quickly regenerates after cutting, trampling or burning and forms impenetrable thickets.

Its prolific regeneration, growth and adaptability resulted into a near pest on cultivable land, wastelands, forest-areas, pasture-lands and in plantations. Worst-affected areas are the Deccan, parts of Kodagu, Wynaad, the Nilgiris and lower hills of western ghats and parts of Uttar Pradesh, Bihar, Meghalaya and probably Assam; difficult to control. Grown as a hedge in India.

UTILIZATION

Reclamation—Being tenaceous, hardy, easy to naturally establish from seed and stumps even under adverse conditions, and able to improve the fertility of exhausted areas, and rocky, gravelly or hard lateritic soil, it is an excellent plant for conservation of soil; adds humus in deforested areas and checks soil- erosion; occasionally used as green manure; can be converted into compost.

Its ability to burn even when green is, however, a source of fire-hazard. Its presence is reported to reduce the basal growth of teak, and harbour pests. Besides mechanical, chemical and biological control, planting of *Ficus elastica, Leucaena latisiliqua, Ricinus communis* and *Tithonia diversifolia* helps in controlling *Lantana.*

Fuel—Quickly burns.

Fodder—Though browsed during scarcity, not relished by cattle; considered to cause jaundice.

Others—Stem: Used as toothbrushes. *Bark:* Antipyretic and antispasmodic; extracts show antibacterial activity. *Leaf:* Used as an inferior tea; employed to polish wood. Yields an oil (0.2%), applied in itches and may be antiseptic. Causes severe icterus in sheep. *Flower:* Yields an oil. *Fruit:* Edible. *Seed:* Contains fatty oil (9%) and essential oil. The latter possesses antimicrobial and anthelmintic properties.

LEUCAENA Benth. (*Mimosaceae)*

Large shrubs or small trees; tropical America and the Pacific Islands, widely distributed in tropics and subtropics; 1 sp in India.

L. latisiliqua (Linn.) Gillis syn. *L. leucocephala* (Lamk.) de Wit; *L. glauca* Benth. WHITE POPINAC, THE LEAD-TREE

Guj–*Lasobaval;* Hindi–*Subabul, vilaitibaral;* Mal–*Takarannimaram;* Oriya–*Rajokasundari;* Tam–*Nattuccavundal, tagarai;* Tel–*Kaniti, nagarikeesari.*

Lakhimpur–*Toriakadam.*

Habit—A large, unarmed, evergreen, fast-growing shrub or a small tree, up to 9 m, some cultivars reaching 18m. *Rootsystem*—deep. *Stem*—puberulous when young, lenticelled with age; some cultivars have thick branchless stems. *Bark*—brownish. *Leaf*—bipinnate, 7.5–18.0 cm long, pinnae ending in a weak spine: leaflets 10–16 pairs, asymmetrical, linear-oblong, 6–12 mm × 2–3 mm, glabrous or nearly so above, pubescent below. *Flower*—small, whitish or pale yellow, in globose heads, 1–3 together; 2.0–2.5 cm diam; April–August but generally almost throughout the year. *Fruit*—dark brown, straight, flat, thin , 15–20-seeded pod, tapering at the base, obliquely triangular at the apex, narrowed at the base; July–November but appears according to flowering. *Seed*—dark brown, small; February–May and July–November; 23,600/ kg; germination 4–6 days, 30–100%; viable for 8–10 years if fumigated and stored in air-tight containers; needs soaking in hot water for 5 min at 70°–80°C or conc. hydrochloric acid or sulphuric acid or scarification for quick and even germination; also needs treatment with *Rhizobium* sp.

Some cultivars, such as 'Cunningham', 'Hawaiian Giant ', 'K-4', 'K-6', 'K-8', 'K-28', 'K-67', 'K-72', 'K-132', 'K-341' and'Peru', have been introduced.

Distribution and Ecology—Native to tropical America, found throughout the plains up to 500 m, and fairly well up to 1300 m. Grows in hedges and near villages. Its rugged habit, deep rootsystem, abundant seed and quick growth enable it to establish even in unfavourable situations. Grows under a wide variety of climatic conditions and withstands a wide variation in temperature and rainfall, and on a wide range of soils, though prefers deep, clayey soils.

CULTIVATION/REGENERATION

Natural Regeneration—Starts producing seed at the age of 6 months. Freely regenerates through self-sown seed and coppicing; growth of coppice (4 m/5 cm) in a year is faster than that of seedling.

Artificial Regeneration—Direct sowing or transplanting the container-raised seedlings or from cutting and stump. *Rhizobium*-inoculated seed is directly sown on contour-furrows or in drills or patches at 1.5 cm depth (10–20 kg/ha); for broadcast 20–25 kg/ha, and for line-sowing 5–7 kg/ha are needed. Closer spacing is adopted for soil-conservation and fodder. Seedlings (60–120-day-old) also are transplanted in pits; addition of farmyard manure and super-phosphate is beneficial; can be planted very close; nursery and plantations are weeded in the early stages. About 100,000 plants/ha are common; higher density of plants also recommended for higher yield of fodder. Harvesting depends upon the need: firewood 2–3-year coppice-rotation; forage-cutting at 1–3-month interval even when 10–15 cm; timber 5-year rotation; yields charcoal 12–24 t/ha/year.*Heteropsylla cubana*, a serious pest, was reported from Tamil Nadu.

Intercropping with other crops and grasses has been recommended. Growing with other crops is reported to increase the yield of crops.

UTILIZATION

Reclamation—A multipurpose, ideal tree for growing on wastelands; basically planted for checking soil-erosion and reclamation. Grown on various wastelands and barren lands, desert-soils, denuded and eroded sites, gullies and ravines, grassy blanks, mined wastelands, tankbeds, canal-banks, roads and railway-sites; reported to be suitable for brackish-water areas, watersheds, slopes; also grows on acidic soils, though poor, and on alkaline coal-spoils. Recommended for agro- and social forestry and encouraged. Suitable for conservation of water. Regularly sheds its leaves providing mulch and green manure, enriching the topsoil. Does not compete with other crops and used as a nurse- or support-crop in various plantations and withstands severe pruning and even stumping serves as windbreak. Grown in alleys, and for gap-filling in forests. Highly suitable for green-manuring and composting. Fixes nitrogen and encourages weeds.

Timber—Treated wood may be useful for furniture, parquet-floorings, studding craft material, poles, posts, rafters, and props. May be useful for pulp and boards.

Fuel—Good firewood (3895–4675 kcal/kg) and makes very good charcoal (7000–7250 kcal/kg).

Fodder—Yield of fresh fodder is very high; suitable for ruminants only (crude protein, 22.0–23.37%). When consumed by non-ruminants in excess, it is reported to be toxic due to leucerine or leucenol, and hair is lost; also causes loss of fertility due to the alkaloids; if feeding is stopped, hair and fertility are restored. Leaf-meal can be employed as a supplement to alf-alfa in poultry-rations. Wilting or soaking reduces toxicity.

Others—Bark: Yields a gum due to gummosis, a substitute for *guar* gum, useful in paper- and food-industry. *Leaf:* Young shoots eaten. Good source of protein and vitamin-A. Contains tannins (3%). *Flower:* Used for pickle. *Fruit:* Immature pod is eaten as vegetable. *Seed:* Dried and parched ones eaten; may be used in concentrates. Powder is used as manure. Yields a fatty oil (8.8%). Used for fancy baskets, purses and ornaments. Powdered seed reduces cholesterol and sugar. Seed forms a base material for preparing cocoa-like drinks.

MADHUCA J.F.Gmel. (*Sapotaceae*)

Trees; India to Australia and Polynesia; 5 spp in India.

*M. butyracea Macb. syn. *Bassia butyracea* Roxb.; *Diploknema butyracea* H. J. Lam. THE INDIAN BUTTER-TREE

Beng–*Gophal;* Hindi–*Phulwara, chiura.*

Habit—A fast-growing, large, deciduous tree, 12–21 m/1.8–3.0 m. *Bark*—dark grey or brownish. *Leaf*—crowded at the apex, 20–35 cm × 7.5–15.0 cm. *Flower*—white, with a sticky fragrance. *Fruit*—sweet-scented,

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*Some treat it under *Aisandra* Pierre.

ellipsoid, blackish, 1–3-seeded berry. *Seed*—glossy brown, 18–20 mm long, with a whitish kernel. *Flowering & Fruiting* —cold season in North India; ripens during June–July; in the Andamans January–April and March–May, respectively.

Distribution and Ecology—Commonly met with in the sub-Himalayan tract and in the outer Himalayas from Kumaun eastwards to Sikkim and Bhutan, up to 1500 m; also found in the Andamans. On the hills, it is chiefly found along the sides of ravines. In the Andamans, it is found in semi-deciduous and evergreen forests.

UTILIZATION

Reclamation—May be useful to grow in the ravines on hills. Useful for block-planting on hills.

Fodder—Processed cake from kernel is fit for feed.

Others—*Flower:* Rich in sugars; jaggery and liquor may be produced. *Fruit:* Thick, soft and sugary pericarp edible. *Seed:* Possesses spermicidal activity on human semen. *Kernel:* Yields a white fat (42–47% of seed, or 60–67% of kernels), used as substitute for *ghee* and coca-butter. May be employed for candles, soaps and lamp-oil. Said to be useful for rheumatic pains. Cake useful as manure; kills worms. Also used as soap.

*[1]**M. indica** J.F. Gmel.syn. *M. latifolia* Macb.; *B. latifolia* Roxb.

THE BUTTER-TREE

Beng, Hindi & Mar—*Mahwa;* Guj–*Mahuda;* Kan–*Hippe;* Mal–*Ilupu, poonam;* Oriya–*Mahula;* Tam–*Illupei;* Tel–*Ippa.*

Habit—A medium-sized to large tree. *Stem*—usually with short, bole and large, rounded crown, 2.4–3.6 m/2.4 m. *Bark*—dark-coloured or grey, cracked. *Leaf*—clustered near the ends of branches, elliptic or elliptic-oblong, 7.5–23.0 cm × 3.8–11.5 cm, coriaceous, pubescent when young, almost glabrous when mature. *Flower*—small, fleshy, cream-coloured, sweet-scented, in dense fascicles near the ends of branches; February–April. *Fruit*—ovoid, up to 5cm long, greenish, turning reddish-yellow or orange when ripe, 1–4-seeded; May–August. *Seed*—brown, ovoid, smooth, shining, 2.5–3.6 cm long; 440/kg; fresh with high percentage of fertility but loses vitality if stored.

Distribution and Ecology—Found throughout the greater part of India, up to 1200 m; everywhere cultivated. Common in deciduous forests and much planted and also protected; characteristic of mixed deciduous forests,

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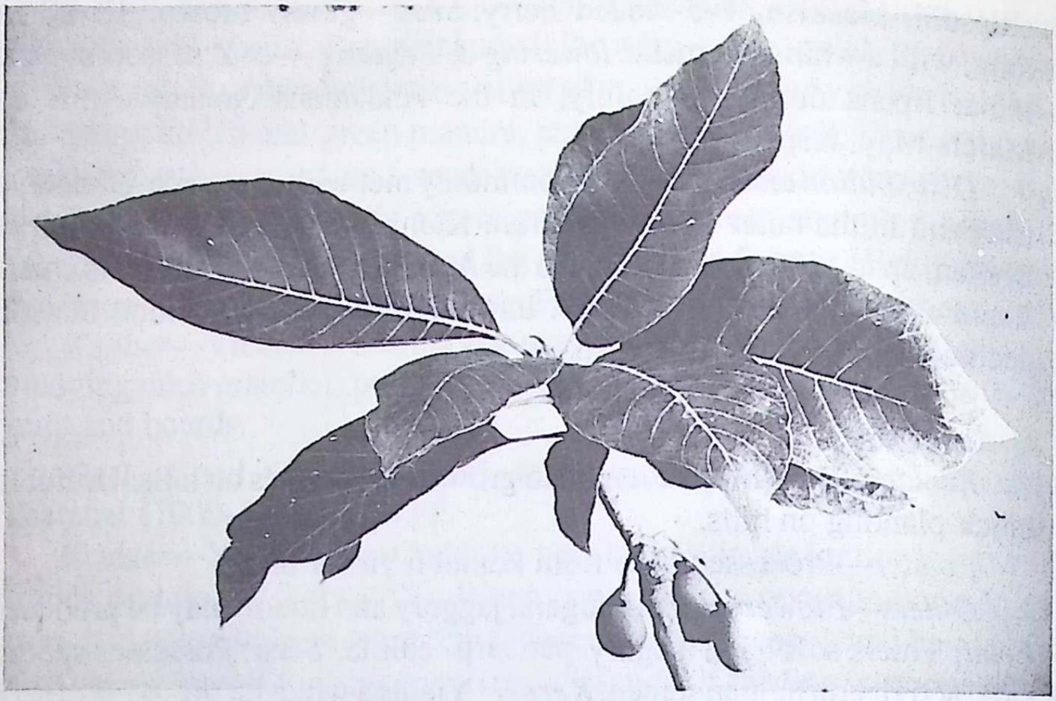
*[1] Some consider it *M. longifolia* (Koenig) Macb. var. *latifolia* (Roxb.) Cheval.



Madhuca indica

usually of a somewhat dry type, often growing on dry, rocky or sandy soil and thriving on the Deccan Trap.

Silvicultural Characters—A strong light-demander, with a spreading rootsystem. Capable of thriving on poor, dry ground. Generally drought- and frost-hardy. Coppices fairly well when cut during dry season. Cattle and deer may browse the seedlings. Attacked by *Loranthus* spp.

CULTIVATION/REGENERATION

Natural Regeneration—Seed germinates in the early rains soon after falling. Protected seedlings survive and grow.

Artificial Regeneration—May be propagated either from direct sowing of fresh seeds or nursery-raised transplants in July. For forests, direct sowing in lines or patches are preferred. Transplanting is risky with a long, delicate taproot. For transplants, seed should be sown in pots or baskets and watered but sparingly. They are transplanted in the second rains. Stumps also can be employed.

UTILIZATION

Reclamation—Recommended for saline and alkaline, black soils and waterlogged areas for reclamation and afforestation. Also recommended for block-planting, agro- and social forestry.

Timber—Beams, doors, frames, carriages, furniture, turnery, agricultural implements, sports-goods, musical instruments; and pulp.

Fuel—A good firewood (sapwood, 4890–4978 kcal; heartwood, 5005–5224 kcal/kg).

Fodder—Leaf given to cattle (crude protein, 9.4%); also used as green manure. Fresh or exhausted flowers are also given as feed.

Others—Bark: Exudes latex which yields a rubbery product; contains tannins (17%) and used in tanning and dyeing. Used in rheumatism, ulcer, iches, bleeding-gums, tonsilitis and diabetes. *Leaf:* Yields tannins (4.86%). Astringent and used as embrocation. *Flower:* Eaten raw or cooked, or after frying or baking into cakes; excessive consumption may cause vomiting. Petals rich in sugar and appreciable amounts of vitamins and calcium. Used for preparing liquors, vinegar, and a syrup useful for jams and sweetmeats; syrup is used as a substitute for honey. Cooling, tonic and demulcent and given in coughs and colds and bronchitis. Possesses antibacterial activity against *Escherichia coli.* Honey edible and employed in eye-diseases. *Fruit:* Eaten raw or cooked (protein, 1.37%); also eaten by animals; rich in starch; within 2–3 days of plucking, starch is converted into sugars, useful for fermenting. Yields a volatile oil (0.03%). *Seed:* Possesses spermicidal activity on human semen. Activated carbon can be prepared from seeds. *Kernel:* Yields an edible oil (20–43%), MAHUA OIL or MAHUA BUTTER, used for soaps. Refined oil used for lubrication, candles, for patching jute and as a raw material for stearic acid. Given as laxative, in rheumatism and skin-diseases. Suitable as a substitute for palm-oil. *Cake:* Used as manure (protein, 15.0–17.4%). Contains a toxic principle, mowrin, which possesses digitalis-like action; also possesses insecticidal and piscicidal properties.

M. longifolia (Koenig) Macb. *B. longifolia* Koenig THE SOUTH-INDIAN MAHUA, MOWRA BUTTER -TREE

*Tel–*Peddaippa.*

Habit—A large, evergreen tree. *Stem*—short, 3.6 m/2.4 m, with a dense, spreading crown. *Bark*—yellowish-grey to dark brown-red and milky inside, scaly. *Leaf*—clustered near the apex, linear-lanceolate, 7.5–12.5 cm×2.5–4.5 cm, tapering towards the base, glabrous when mature. *Flower*—pale yellow, many, small, with rusty, pubescent calyx and fleshy corolla, aromatic, in dense clusters near the ends of the branches; November–December or February–May depending upon locality. *Fruit*—ovoid, 5cm long, 1–2-seeded berry, yellow when ripe; June–August. *Seed*—compressed, yellow, or light brown, shining, smooth; 360–450/kg;

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* Many vernacular names are common to both *M. indica* and *M. longifolia*.

germination within 15 days, fertility of fresh seed high; viable for only 6 months.

Distribution and Ecology—Konkan southwards; extends into the Deccan and many parts of South India; also cultivated in avenues. Chiefly in the monsoonal forests along the banks of rivers and streams, and in ravines. Drought- and frost-hardy.

Cultivation/Regeneration—Similar to that of *M. indica*.

UTILIZATION

Reclamation—Can be grown in semi-arid, dry lands; thrives on all types of soils with considerable depth of loam. Recommended for reclamation of mined sites, for field-bunds in agro- and social forestry.

Other uses are similar to those of *M. indica*.

MANGIFERA Linn. (*Anacardiaceae*)

Branched evergreen trees; tropical and subtropical parts of South-East Asia; 3–4 species in India.

M. indica and its innumerable cultivars are mainly cultivated for one of the most important edible fruits.

M. indica Linn. THE MANGO-TREE

Beng & Hindi–*Am;* Guj–*Amri;* Kan–*Maavu;* Mal–*Aamram* , *maavu;* Mar–*Amba;* Tam–*Maanga*, *maavu;* Tel–*Maamidichettu, maavi*.

Habit—A large, evergreen tree, up to 45 m, with a dense, dome-shaped crown. *Bark*—thick, rough, dark grey, flaking off when old. *Leaf*—linear-oblong or elliptic-lanceolate, 10–30 cm × 2–9 cm. *Flower*—tiny, reddish-white or yellowish-green, pungently odorous, in large panicles: male and female flowers on the same panicle; South India: January–March; North India: February–April. *Fruit*—drupe, variable in form and size, green, yellowish or with reddish splash, fibrous or non-fibrous; March to July and June–July. *Seed*—solitary, ovoid-oblique, covered with hard, fibrous endocarp; 10–237/kg; germination 30 days, very high; viable for 20–30 days; can be stored at low temperature; may be soaked in water.

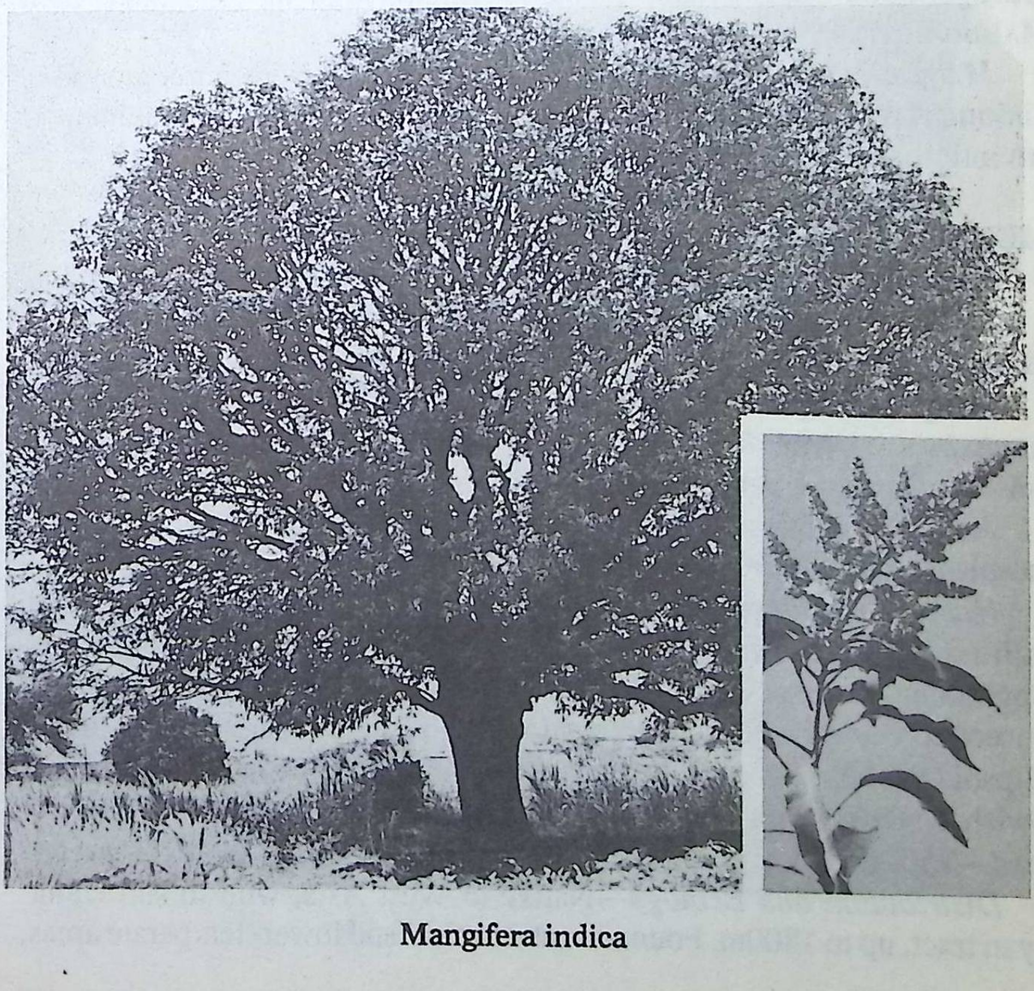
Distribution and Ecology—Found wild throughout India; also cultivated in plantations and orchards, on field-borders, homeyards and in avenues for its fruit. Grows in tropical and sub-tropical climates, with abundant moisture, in the hilly forests, particularly near watercourses and ravines. Thrives on a wide variety of soils.

Silvicultural Characters—A shade-bearer; needs protection from the sun in the first 3–4 years. Severe drought affects the plant. Withstands ordinary frost.

CULTIVATION/REGENERATION

Natural Regeneration—Freely occurs in the open, moist places, or after rains, but seedling dries under the sun; under shade or bushes survives.

Artificial Regeneration—Through seed, transplanting, grafting, budding, air-layering, root-cutting and marcotting. Seed can directly be sown in June or July in beds or seedling transplanted. For vegetative propagation, potted seedlings are kept in partial shade for about one year and when they attain a height of *c* 45 cm, and a thickness of 6–12 mm, they are ready for grafting. Choice cultivar is grafted, cared under shade for *c* 180 days and then planted in the field. The best time for planting in northern and western India is July to August and in southern India July to December at 12–18 m in pits of 60–90 cm × 60–90cm. A mixture of 9 kg farmyard manure, 2.5 kg bonemeal and 9 kg woodash is recommended for manuring one year plants. Responds to further manuring. Needs irrigation in the first few years and also in sandy or shallow soils with scanty rainfall; excess moisture may, however, retard flowering.



Mangifera indica

UTILIZATION

Reclamation—Useful for reclaiming wetlands, waterlogged areas, grassy lands, island-regions and ravines. Also recommended for agro- and social forestry.

Timber—Plywood, packing-boxes, agricultural implements, furniture, and other constructional works.

Fuel—Good firewood. Yields a hard charcoal of high calorific value.

Fodder—Goats eat leaf.

Others—*Bark:* Yields tannins (16–20%) and a colouring-matter. Astringent. Exudes a gum, substituted for gum arabic. *Leaf:* Tender ones consumed as vegetable. Mature ones used as fodder. Leafash used for burns and scalds. *Flower:* Astringent; given for diarrhoea, dysentery. Yields a pale-brownish essential oil used in *Am-attar*. *Fruit:* Highly prized and ripe ones eaten; used to prepare juice, mango-leather, squash, jams, jellies, canned products, etc; unripe ones pickled in a variety of forms. *Kernel:* Eaten (protein, 9.5%) and also given as feed to cattle and poultry; powder astringent and anthelmintic. Yields an edible, solid fat (6–12%), called MANGO-BUTTER.

M.sylvatica Roxb. (Assam–*Ban-am*) is a tall, evergreen tree, found in Sikkim, Assam, Khasi hills and the Andaman Islands. The fruit and timber are inferior to those of *M. indica* but are similarly used.

MELIA Linn. (*Meliaceae*)

Trees, sometimes shrubs; tropical Asia and Australia; 2 spp in India.

M. azedarach Linn. THE PERSIAN LILAC, BEAD-TREE

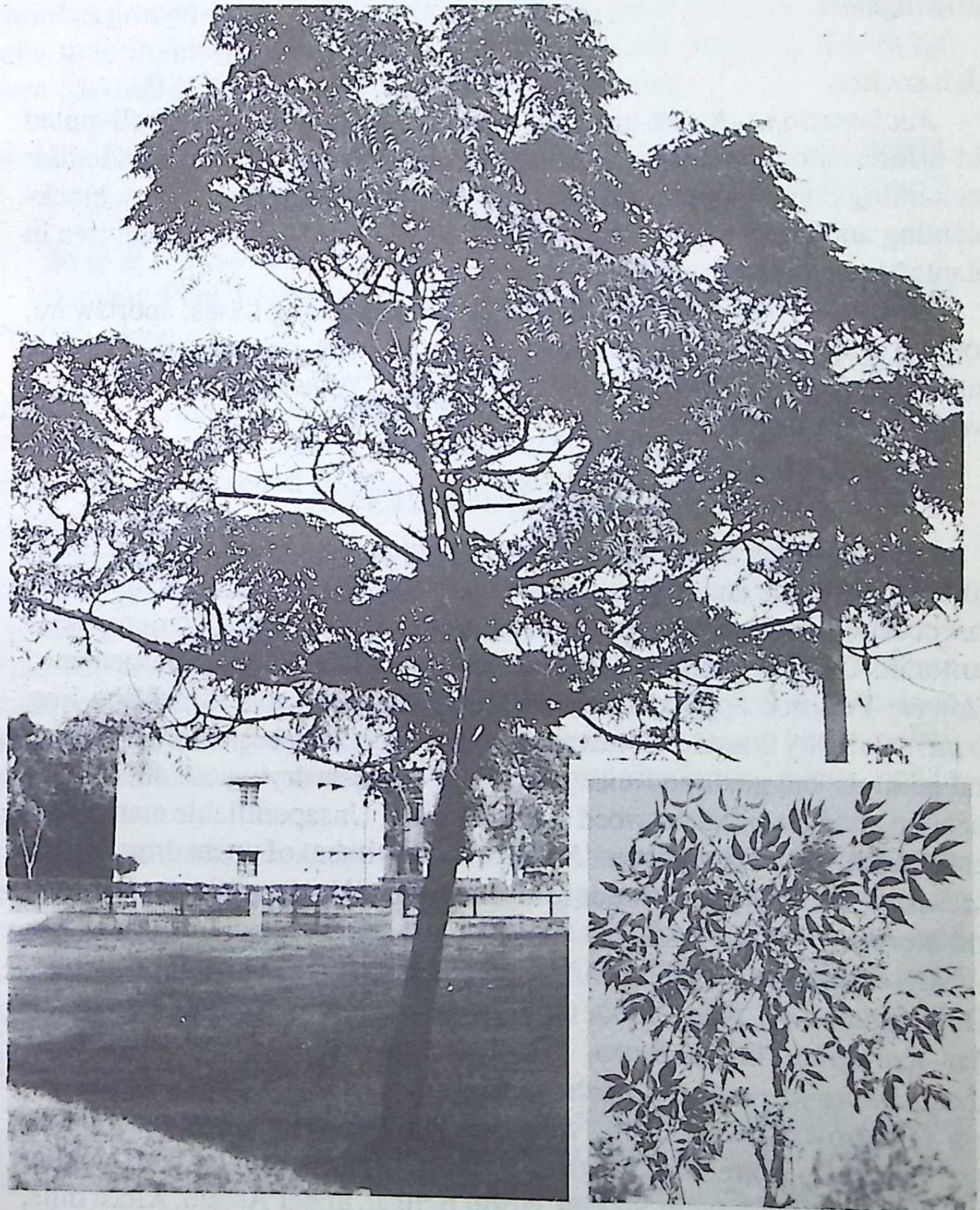
Beng–*Mahanim;* Guj–*Bakam limbodo;* Hindi–*Bakain;* Kan–*Arebvu, hutchuburi;* Mal–*Karin vembu;* Mar–*Pejri;* Tam–*Malaivembu;* Tel–*Turakaveepa, verriveepa.*

Assam–*Thamaga;* Khasi–*Dieng-jah-rasang;* Punjab *Drek;* TRADE–*Persian Lilac.*

Habit—A moderate-sized, deciduous tree, 9–12 m. *Stem*—cylindrical, with a spreading crown, 3.5 m/1.0–2.5 m. *Bark*—grey, rough, with shallow, longitudinal furrows. *Leaf*—bi- or occasionally tripinnate: leaflets ovate or lanceolate. *Flower*—lilac, fragrant, in axillary panicles; March–May. *Fruit*—ellipsoid-globose, smooth first becoming wrinkled, green when raw, yellowish when ripe, in clusters, 4–5-seeded; takes one year for ripening. *Seed*—750–1400/kg; germination 15–40 days, 30–80%; viable for 2 years.

Distribution and Ecology—Native to West Asia, wild in sub-Himalayan tract, up to 1800m. Found in sub-tropical and lower- temperate areas, arid and semi-arid zone, *terai* and *babhar* zone and also in semi-moist areas. Cultivated in plains for ornament in avenues.

Silvicultural Characters—A light-demander. Though suffers from drought and frost, hardier than margosa. Produces rootsuckers when roots exposed or injured. Coppices well. Roots superficial and tree may fall; also branches are brittle and the whole stem may be broken by wind. Young plants are browsed. Burrs are often produced.



Melia azaderach

CULTIVATION/REGENERATION

Natural Regeneration—Freely regenerates from seed during rains.

Artificial Regeneration—Possible through direct sowing, transplanting, stem- and root-cuttings, stumps and rootsuckers, and transplanting being the best. In the nursery, the seed is sown at 5.0–7.5 cm apart during February–May, covered and regularly irrigated and weeded. Transplanting may be done after the first rains or towards a cold weather before the new growth starts.

UTILIZATION

Reclamation—A fast-growing but short-lived tree, very well-suited for afforestation, but needs replacement after 20 years. Recommended for reclaiming ravines and mined sites. Grown for shelterbelts, hedges, block-planting and under social forestry. Cultivated as ornamental shade-tree in plantations of coffee and tea.

Timber—Toys, cigar, ammunition-boxes, packing-cases, sportsware; roofing material, agricultural implements, furniture, ornamental plywood, turnery and musical instruments; and for pulp. Aqueous extract of heartwood useful in asthma.

Fuel—Used as firewood.

Fodder—Leaf lopped (crude protein, 21.5%).

Others—*Leaf:* Eaten after boiling with vegetables. Juice anthelmintic, diuretic, antilithic and emmenagogue; decoction astringent and stomachic. Insect-repellant. Used as green manure. *Bark:* Anthelmintic, comparable to santonin. Contain tannins; yields a gum useful in spleen enlargements. *Flower:* Poultice applied to eruptive skin-diseases and for killing lice. *Fruit:* A whisky is made; stones are used as beads. May be poisonous to man and animals, but goats and sheep eat. *Seed:* Yields a drying oil (40%), used for soap and hair-oil; prescribed in rheumatism. Unsaponifiable matter possesses antibacterial properties. *Kernel:* A constituent of unani drug *Hab-e-Rasvath*, used in haemorrhoids and other bleeding conditions of rectum and uterus.

M. composita Willd. syn. *M. dubia* Hiern (Fl Br Ind), non Cav. (Guj–*Kadukajar;* Kan–*Hebbevu, karibevan;* Mal & Tam–*Malaivembu;* Mar–*Kuriaput;* Oriya–*Batra;* Tel–*Munnatikaraka;* Garo–*Aming-gok;* Khasi–*Dieng-ja-rasang;* Lepcha–*Silot-kung;* TRADE–*Malabar-nimwood*) is a fast-growing tree, 20 m, with dark-brown, exfoliating bark, bi- or tripinnate leaves, greenish, fragrant flowers in dense panicles and ovoid or ellipsoid drupes, found in Sikkim, North Bengal, upper Assam, Khasi hills, hills of Orissa, Northern Circars, Deccan and western ghats, at 1500–1800 m.

Valuable for reforestation in dry areas, and planted for ornament in avenues and for shade in plantation.

MELILOTUS Mill. (*Fabaceae*)

Annual or biennial herbs, commonly known as SWEETCLOVER; temperate and warm regions of the world and naturalized or cultivated elsewhere; 3 spp in India.

Some species are widely grown for fodder and green manure; also useful as ground-cover and soil-binders; though grow over a wide range of soils, they prefer well-drained neutral or alkaline soils. Seeds in a kilo range from 550,000 to 605,000 and scarified before sowing.

M. alba Desr. WHITE SWEETCLOVER, BOKHARA CLOVER, WHITE MELILOTUS

Beng & Oriya–*Safed benmethi.*

Bombay, Punjab & Uttar Pradesh–*Safed sanji;* Delhi–*Khandai;* Madhya Pradesh–*Ranmethi.*

Habit—An erect or decumbent, biennial herb, 1m or more. *Leaf*—trifolioate: leaflets ovate, oblong or obovate, entire or distantly serrulate. *Flower*—white, in axillary racemes. *Fruit*—ovate, oblong or obovate, indehiscent, 1–2-seeded pod, brown when ripe. *Flowering & Fruiting* — December–April.

Distribution and Ecology—Found throughout India as weed, chiefly in North India, up to 4000 m in the Himalayas. Also cultivated for fodder in Punjab, Uttar Pradesh, Madhya Pradesh and Tamil Nadu, and in Andhra Pradesh. Var. *annua* Coe (HUBAM SWEETCLOVER) has been introduced into India for fodder. A weed of cultivation during winter. Prefers well-drained alkaline soil and is sensitive to soil acidity. Var. *annua* has received attention because it grows even on poor soils and yields good silage, rich in protein.

Cultivation/Regeneration—Comes up well under irrigated conditions, but does not give a good ratoon-crop. Propagation is through seed or cutting; seed-rate varies from 4.4–27.5 kg/ha, according to the soil and climatic conditions; and for var. *annua* 16.5–17.5 kg/ha. Reported to be attacked by a mildew.

UTILIZATION

Reclamation—Recommended for alkaline soils to be grown for fodder (crude protein, 4.1%). Var. *annua* grows even on poor lands improving the soil-fertility and gives a good cover; used as green manure. Fixes nitrogen.

Provides a good pasture for honeybees.

Fodder—Var. *annua* yields substantial fodder. The herb can be converted into hay (crude protein, 16.5%) and silage (crude protein, 4.5%). In cattle, instances of bloating have, however, been reported. Detoxicated seed-cake is a good protein supplement to cattle.

Others—*Herb:* Possesses astringent and narcotic properties; sometimes causes colic. *Seed:* Contains crude protein (39.4%) and oil (7.6%). Oil suitable for paint and varnish industry.

M. indica All. syn. *M. parviflora* Desf. ANNUAL YELLOW SWEET-CLOVER

Beng, Bihar, Delhi & Uttar Pradesh–*Senji, metha, banmetha;* Oriya–*Ban-methi;* Bombay–*Van methica.*

Habit—An erect, annual herb, 0.5 m. *Leaf*—trifoliolate: leaflets obovate or oblong-lanceolate, retuse or emarginate. *Flower*—yellow, in slender racemes. *Fruit*—ellipsoid, oblong-ellipsoid, compressed. *Flowering & Fruiting* —cold season; sometimes continues during summer.

Distribution and Ecology—Almost throughout India, up to 1650 m; more common in North India, chiefly cultivated in Punjab for fodder. Common as winter-weed in moist wasteplaces. Requires medium to high fertility and resists alkalinity.

Cultivation/Regeneration—Grows in Punjab as an irrigated cold-season crop along perennial canals and on irrigated lands. Common where sugarcane is grown; and can also be cultivated on *bajra* soils. Also grown in rotation with various cereals and tobacco and in mixture with barley and oat. Seed (44–55 kg/ha) is sown broadcast on moist or dry seed-bed during September–November. Covered with soil, and immediately irrigation is given when sown on dry beds. Plots are irrigated 7–10 days after sowing, and later as and when required and weeded. Addition of 58–78 kg ammonium phosphate or a mixture of 22 kg nitrogen and 66 kg phosphoric acid/ha is beneficial. Harvested 2–4 times during February–April when in full flower.

UTILIZATION

Reclamation—Recommended for improving the alkaline soils in Punjab; also useful for reclaiming saline areas and as a cover- and green-manure crop. Fixes nitrogen.

Fodder—Given as a green fodder (crude protein: fodder, 3.3%; dry pods, 25.3%); rich in calcium. Preflowering stage may cause bloating. Can be converted into silage (crude protein, 2.1%) with any straw and hay (crude protein, 18.6%). When fed alone and in excess, it causes lethargy, tympanites, and paralysis; milk is tainted.

Others—Herb: Astringent and narcotic; and used as an emollient for swellings in diarrhoea.

M. officinalis Lam. YELLOW SWEETCLOVER, COMMON MELILOT

Habit—A tall, robust biennial herb, 1 m or more. *Leaf*—trifoliolate: leaflets obovate, oblong or oblanceolate. *Flower*—yellowish, in lax racemes. *Fruit*—ovoid, transversely rugose, compressed pods, brown when ripe. *Seed*—oval, 2–3 mm in diam, yellowish-green, smooth.

Distribution—Recorded from Nubra and Ladakh, at 3000–4000 m; also cultivated in some areas for fodder.

UTILIZATION

Reclamation—A high-altitude plant, may be grown for conservation of soil and fodder in cold deserts. Fixes nitrogen. Useful as honeybee pasture.

Fodder—Given as fodder; can be converted into hay (crude protein, 20.3%).

Others—Herb: Carminative, styptic and emollient. Used in cigarettes for asthma; contains a coumarin having anti-inflammatory and antioedema activity. *Seed:* Occasionally found as impurity in imported food-grains and are responsible for tainting the bread. Poisonous to horses. Yields a fatty oil (7.8–8.3%).

MORINGA Adans. (*Moringaceae*)

Fast-growing trees; India to western Asia and Africa; 2 spp in India.

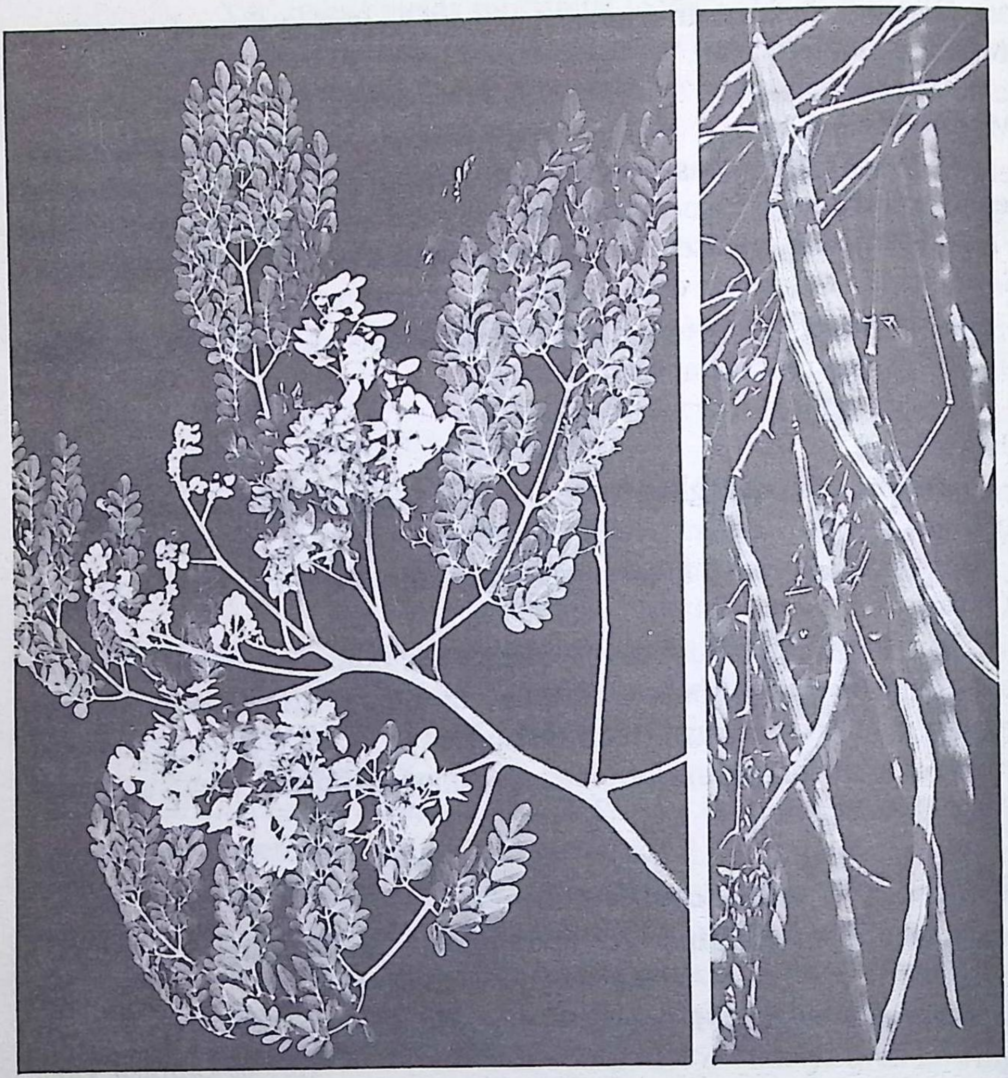
M. oleifera Lam. syn. *M. pterygosperma* Gaertn. DRUMSTICK TREE, HORSE-RADDISH TREE

Beng, Hindi, Oriya, Assam & Punjab–*Sajina;* Guj–*Midho-saragavo;* Kan–*Nugge;* Mal–*Moringa, murinna;* Mar–*Shevgi;* Sans–*Shobhanjana;* Tam–*Murugai;* Tel–*Mulaga, tellamunaga.*

Santal–*Mungaarak.*

Habit—A small or medium, brittle tree, with young parts tomentose, 10 m. *Bark*—light-brown, thick, soft, corky, deeply fissured. *Leaf*—tripinnate: leaflets elliptic. *Flower*—white, fragrant, in large panicles with sharp, pungent taste. *Fruit*—pendulous, greenish, triangular, ribbed, pod-like capsule, 22.5–50.0 cm long or more; January–May or sometimes almost throughout the year. *Seed*—trigonous, with wings on angles; April–June or depends upon flowering; 6000–9000/kg; germination 20–30 days, 66%; viable for only 6 months; needs soaking in water; dispersed by wind.

Distribution and Ecology—Indigenous to India, found wild in the sub-



Moringa oleifera

Himalayan tract and cultivated all over the plains. Very often cultivated in hedges and homeyards. Alluvial land in or near sandy beds or rivers and streams; grows on all types of soils and thrives best under the tropical, insular climate of South India.

Silvicultural Characters—A light-demander; gives little shade. Drought- and frost-hardy.

Cultivation/Regeneration—Propagation is from seeds during July–August or cuttings, the latter being preferred; plants raised from seeds produce fruits of inferior quality. A good tree yields 1000 fruits a year. Wild trees usually bear inferior, sometimes bitter fruits.

UTILIZATION

Reclamation—Recommended for growing in gullies and ravines; also recommended for agro- and social forestry as it gives very meager shade. Provides humus which acts as mulch.

Timber—Pulp suitable for paper.

Fodder—Leaf lopped (crude protein, 14.29–21.88%).

Others—Plant: Extracts used in indigenous drugs: RUMALAYA prescribed in joint pains especially of knee; SEPTILIN useful in exodontia, dental infections, upper respiratory tract infections, chronic suppurative otitis media, dermatology and burns. *Bark:* Exudes a reddish gum used in calico-printing. Juice useful in eczema. Forms a constituent of *Churna*, a drug for lower urinary-tract infections. *Leaf:* Eaten as potherb (protein, 6.7%); contains several essential amino acids. Rich in vitamin-A and -C and useful as emetic, in scurvy and catarrhal affections, contains some important minerals also. Juice shows antibiotic and antifungal activity due to pterygospermin and may be useful in preserving fruits and vegetables and in treating seeds. *Root:* Used as condiment or for garnishing. Young roots rubefacient and vesicant. *Rootbark:* Contains moringine and moringinine; the latter increases blood-pressure. *Flower:* Cooked and eaten. Tonic, diuretic and cholagogue. Rich in potassium and calcium. *Fruit:* Used as vegetable and for other culinary preparations; also pickled (crude protein, 2.5%). Contains vitamin-A and -C and several essential amino acids. *Seed:* Consumed after frying and tastes like groundnuts. Antipyretic. Powder used as natural coagulant for purification of water. Extract possesses antimicrobial activity. Yields an oil (34.7%); useful in rheumatism and gout. Also useful for illumination, cooking and in cosmetics. *Cake:* Bitter (crude protein, 38.4%). Used as manure.

MORUS Linn. (*Moraceae*)

Trees or shrubs; temperate and sub-tropical regions of the northern hemisphere; 5 spp occur in India.

Commonly known as MULBERRY, leaves of a few species are fed to silkworms. Some are grown for their edible fruits and useful timber.

M. alba Linn. THE MULBERRY

Beng, Hindi, Mar, Kashmir & Punjab–*Tut;* Guj–*Shetur;* Kan–*Hipnerle;* Oriya–*Tuto;* Tam–*Musukette;* Tel–*Reshmechettu, pippalipanduchettu.*

Kumaun–*Siahtut;* TRADE–*Mulberry.*

Habit—A monoecious, occasionally dioecious, shrub or moderate-sized tree. *Stem*—fairly cylindrical, straight, bole up to 15 m/1.8 m. *Bark*—

dark greyish-brown, rough, with vertical fissures. *Leaf*—very variable, ovate or broadly ovate, serrate or crenate-serrate, often deeply lobed. *Flower*—inconspicuous, greenish; male spike (catkin) lax-flowered, broadly cylindrical or ovoid; female spike ovoid, pedunculate; generally February–April. *Fruit*—syncarp, up to 7 cm long, consisting of many drupes, enclosed in fleshy perianth, ovoid or sub-globose, white to pinkish-white, purple or dark purple to black; March–June. *Seed*—extremely small, 418,400–700,000/kg; germination 9–45 days, 70–100%; may be treated with camphor-water.

Several cultivars are grown for different silkworms.

Distribution and Ecology—Native to China, extensively cultivated throughout the plains and in the hilly areas of Himalayas, up to 3300 m, and in many other States for leaf-feed of silkworms; also grown for fruits and ornament. Grows well under varying conditions of soils and climate; and highly salt-tolerant. Thrives well on heavy loam and black cotton-soils.

Silvicultural Characters—Does not withstand shade and waterlogging. Frost-hardy. Coppices and pollards well. When grown close, the tree develops a clean, long bole. Liable to windbreak. Regularly pruned to a desired height.

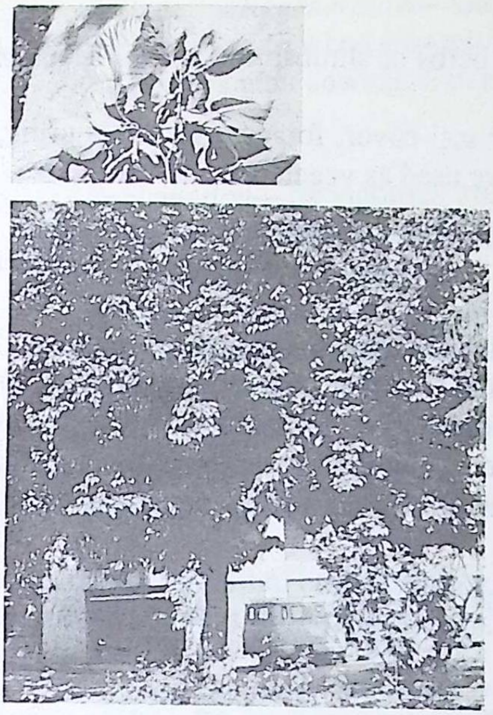
CULTIVATION/REGENERATION

Natural Regeneration—Seed freely germinates and dispersed by birds and other animals and humans.

Artificial Regeneration—Through seed, cuttings, transplanting, stump, grafting and budding. Land is thoroughly prepared before the rains. Organic manure (37–63cartloads/ha) is ploughed in. A mixture of 302 kg groundnut cake and 137kg ammonium sulphate per hectare is suggested for irrigated area. Once established, no manure is needed. Seed is sown and covered with earth and ash and watered. Beds are weeded; 10–15 cm plants are transplanted at 1.2 m for bushes and 1.2 m plants for trees. Branches of 22–30 cm with 3 buds are cut and planted for rooting and the sprouted ones are transplanted. Seedling-raised plants are considered better for quality leaf. Several diseases have been recorded, such as mildew, leafspot, trunkrot and *shownia*. A few pests have been recorded, sucking sap, boring tunnels or girdling the stem. Control measures have been suggested.

UTILIZATION

Reclamation—Recommended for reclaiming waterlogged areas and ravines. Highly salt-tolerant. Also recommended as shade-plant for *Dalbergia sissoo*. Mulberry acts as soil-protector and also promotes clean



Morus alba

M. serrata

growth of sissoo; grown on roadside and in avenues. Suitable for agroforestry and shelterbelts in controlling sand-drift areas.

Timber—Sportsgoods, house-building, agricultural implements, furniture and turnery, and paper-pulp.

Fuel—Provides firewood.

Fodder—Nutritious and palatable leaf (crude protein, 27.64%); rich in minerals and vitamin-A and -B-complex group and is stated to increase milk when fed to cattle. Young leaves of full size are the best for feeding silkworm larvae.

Others—Bark: Used for paper-making. Yields a fibre suitable for textiles. *Leaf:* Sometimes eaten as vegetable. Extract used in diabetes and throat diseases. *Fruit:* Eaten fresh or made into juice, stews and tarts. Cooling and laxative.

M. serrata Roxb. (Himalayan Mulberry) is a common mulberry in Himalayas, cultivated for shade, fruits, fodder and feeding silkworms. The tree coppices well and produces rootsuckers, and recommended for agroforestry. Timber hard and tough. Leaf lopped for fodder; milk-yield increases in cattle.

MUCUNA Adans. (*Fabaceae*)

Annual or perennial twining herbs or shrubs; tropics and subtropics; 15 spp in India.

Some species are grown for soil-cover, forage, green-manuring, or ornament; young pods of some are used as vegetable.

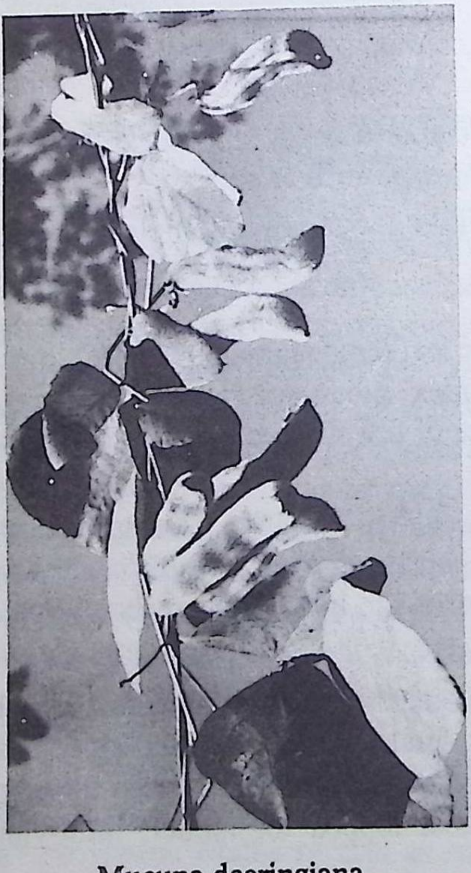
M. deeringiana (Bort) Merrill syn. *Stizolobium deeringianum* Bort

FLORIDA OR GEORGIA VELVET-BEAN

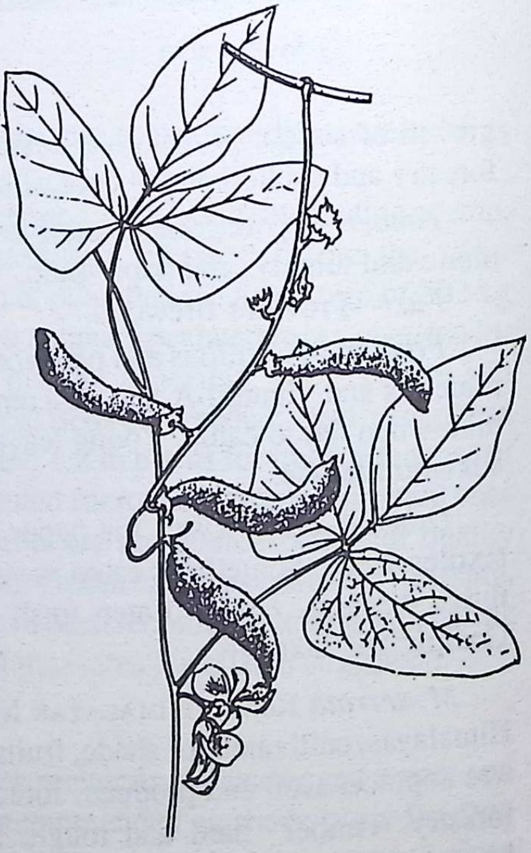
Punjab–*Makhmalisem.*

Habit—A herbaceous, pubescent, trailing or twining annual, up to 18 m or more in length. *Leaf*—trifoliolate: leaflets ovate or rhomboid, 5–15 cm long. *Flower*—purple. *Fruit*—ridged, 3–5-seeded pod, densely covered with black pubescence, 5.0–7.5 cm long. *Seed*—nearly globular, usually speckled, streaked, marbled brown or black; also pure grey or black not uncommon; germination 7 days.

Distribution and Ecology—Introduced into India for fodder and cultivated in warm, moist condition; can be grown on any type of soil but prefers medium to light-loam.



Mucuna deeringiana



M. pruriens

Cultivation/Regeneration—Grows as *kharif* crop either alone or mixed with maize or *jowar*; when grown for forage, the crop is ready for harvesting in 90–100 days after sowing. Can also be grown in mixtures.

UTILIZATION

Reclamation—Its vigorous growth smothers weeds and provides an ideal cover for preventing soil-erosion from wind and water; also grown for green-manuring. Fixes nitrogen.

Fodder—Grown pure or in pastures; provides good fodder (protein, 15.14%); also fed as hay. Fruit used in rations (protein, 18.1%) for dairy-cows, and for fattening cattle and sheep.

Others—Fruit: Eaten as vegetable; a good source of protein.

M. pruriens (Linn.) DC. syn. *M. prurita* Hook. COMMON COWITCH, COWHAGE

Beng–*Bichchoti;* Guj–*Kavatch;* Hindi–*Kaunch;* Kan–*Nasukunni; hasagunida;* Mal–*Naiorn;* Mar–*Kavacha;* Oriya–*Kaincho;* Tam–*Poonaipidukkan;* Tel–*Dulagondi, duradaguntaakuchettu.*

Lepcha–*Kajukop-rik;* Mundari & Santal–*Itika;* Punjab–*Kawanch.*

Habit—A herbaceous, twining annual. *Leaf*—trifoliolate: leaflets broadly ovate, elliptic or rhomboid, ovate. *Flower*—purple, in axillary pendulous racemes. *Fruit*—curved, 4–6-seeded, longitudinally ribbed pod, densely clothed with persistent pale-brown or grey, irritant bristles, 5–10 cm×1.5–1.8 cm. *Seed*—black, ovoid, 12 mm long.

Distribution and Ecology—Almost all over India and in the Andaman and Nicobar Islands; occasionally cultivated. Found in bushes and hedges, damp places, ravines and scrub-jungles and dry-deciduous, low forests throughout the plains of India; luxuriant in *sal* plantation of West Bengal.

UTILIZATION

Reclamation—Hardy and vigorous growing; forms a thick soil-covering; smothers weeds. Useful as a green manure and cover-crop. Fixes nitrogen.

Fodder—Given when in flower.

Others—Herb: Source of a drug for Parkinson's disease; also used in indigenous drugs: MUSTONG, useful in male sexual inadequacy; GERIFORTE, useful in *senile pruritus* and fatigue. *Leaf:* Young ones used as vegetable. Applied to ulcers. *Root:* Stimulant, diuretic. *Fruit:* Used as vegetable; used as famine food (crude protein, 25.03%) after repeated boiling. Contains prurienimine which slows the heart and depresses blood-pressure. Extract possesses anthelmintic properties. Hairs on the pod cause itching and cause blisters and dermatitis. *Seed:* Astringent; possesses insecticidal and antimicrobial activity. Yields a fatty oil (5.9%); sterol fraction exhibits anti-inflammatory and anticholesterenic properties.

M. cochinchinensis Cheval. (LYON-BEAN) is an annual, twining herb, with white or pale-purple flowers and glabrescent pods, cultivated in West Bengal and Bihar. Growth is vigorous and useful as cover-crop or for green manure. Pods and seeds are eaten; also useful as fodder.

OCHTHOCHLOA Edgew. (*Poaceae*)

Annual or perennial grasses; India to North Africa; 1 sp in India.

O. compressa (Forssk.) Hilu syn. *Eleusine compressa* (Forssk.) Aschers & Schwein. f. ex Christensen; *Panicum compressum* Forssk.; *Eleusine flagellifera* Nees

Hindi–*Chhimber, ghantil;* Rajasthan–*Ghora dhab.*

Habit—A prostrate, profusely branched and widely spreading perennial. *Stem*—smooth, stiff, rooting at distant, thickened, leafy nodes, internodes 10–20 cm long, culm slender. *Leaf*—linear-lanceolate, acuminate, rigid. *Spike*—3–6. *Spikelet*—long, subsessile or shortly pedicillate, 4–6-flowered.

Distribution and Ecology—Found in North-West India, particularly arid regions. Grows in most arid, eroded rocky areas; found on gravel and sand. Extremely hardy perennial. Woody stolons root at nodes.

UTILIZATION

Reclamation—Most suitable for controlling soil-erosion in arid regions; stabilizes sand-dunes, deep sandy soils, sand-stones, rocky and semi-rocky areas, saline flats and depressions and mineral spoils. Also ideal for rangelands.

Fodder—A fairly good fodder for cattle.

OUGEINIA Benth. (*Fabaceae*)

Trees; 1 sp native to India.

O. oojeinensis (Roxb.) Hochr. syn. *O. dalbergioides* Benth. SANDAN

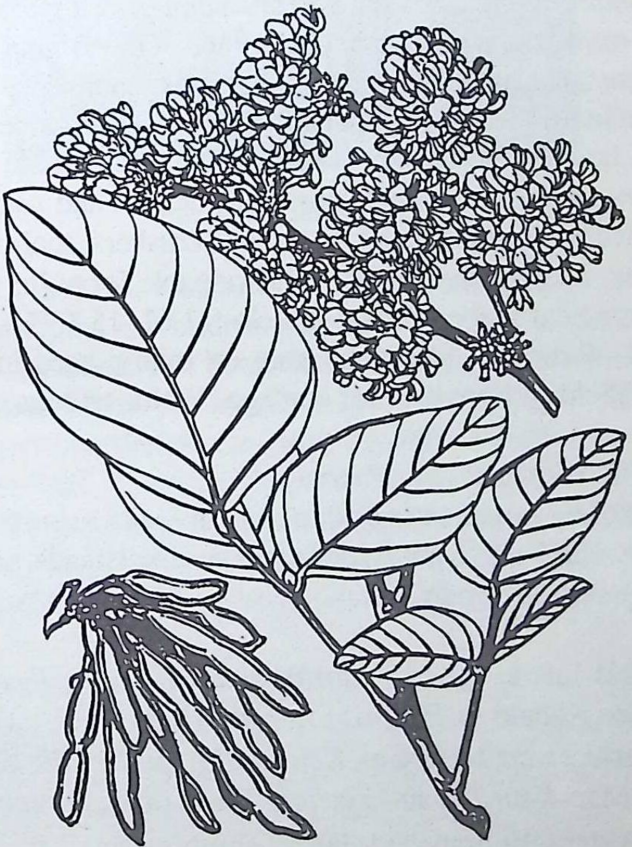
Beng–*Tinis;* Guj–*Tanach;* Hindi–*Sandan;* Kan–*Kari-honne;* Mal–*Malavenna;* Mar–*Kala-phulas;* Oriya–*Banjan, ruta;* Tam–*Narivengai;* Tel–*Tellamoduga.*

Bihar–*Ruta;* Lepcha–*Sadanpipli;* Madhya Pradesh–*Tinsa.*; TRADE–*Sandan.*

Habit—A small to medium-sized, deciduous tree, 12–18 m/1.35–2.10 m. *Rootsystem*—besides taproot, often twisted and branched lateral and superficial roots, often of great length and considerable thickness, spread near the surface; possesses buds. *Stem*—fairly straight to crooked trunk, with a full and rounded crown in well-developed trees. *Bark*—ash-grey or brown with deep irregular and horizontal cracks. *Leaf*—pinnately trifoliolate: leaflets coriaceous. *Flower*—white or pink, in fascicled racemes; February–March. *Fruit*—flat, light-brown, 2–5-seeded pod; May–June. *Seed*—light-brown, flat, reniform; 28,000/kg; germination, 70–100%; dispersed through wind.

Distribution and Ecology—Outer Himalayas and sub-Himalayan tracts from Jammu to Bhutan, up to 1500 m, and extending from Rajasthan through the whole of northern and Central India into the greater part of peninsular India; sometimes planted for ornament. Found in mixed deciduous forests and *sal*- forests. Not exacting to soil and found on a variety of soils and geological formations, on land-slips, boulders, banks and sides of rivers and exposed situations. Abundant on bare loose ground, roadsides and on cultivated fields. Frost- and drought-hardy in later stages in *terai* and *babhar* zone.

Silvicultural Characters—A light-demander. Hardy, but needs protec-



Oujeinia oojeinensis

tion when young as it is drought- and frost-tender. Produces numerous suckers, particularly along steep banks and hillsides. Coppices well. Needs protection from fire.

CULTIVATION/REGENERATION

Natural Regeneration—One of the first species to appear after the rains. Seedlings establish themselves best on bare, loose ground and profusely appear on the roadsides, landslips and even on cultivated grounds. Rootsuckers also are important for natural regeneration, particularly on hillsides.

Artificial Regeneration—Through seeds and root-cuttings. Seeds are directly sown in lines in ploughed fields before monsoon; regular weeding essential. Transplanting also can be done, but needs care due to its long taproot. Sown in the nursery in May or early June and regularly watered, and transplanted when very young.

UTILIZATION

Reclamation—Suitable for arid and semi-arid regions. Production of numerous rootsuckers on or near the surface of the ground greatly helps in clothing unstable steep banks and hillsides, landslips, roadsides, etc. Recommended for agro- and social forestry. Fixes nitrogen.

Useful host for lac-insect.

Timber—A recommended substitute for teak and *sal*. Carts and carriages, agricultural implements, sugarcane crushers, tool-handles, rafters, beams, door- and window-frames; and valuable for pulp.

Fodder—Leaf lopped (crude protein, 11.61–15.13%).

Others—Bark: Exudes a red gum on injury; used in diarrhoea and dysentery. Yields a fibre best for cordage. Yields tannins (17%).

PANDANUS Stickman (*Pandanaceae*)

Palm-like, evergreen trees or shrubs, many possessing stilt-roots; moist tropics of the Old World from Africa to the Pacific Islands, particularly near the watercourses; 36 spp in India.

P. fascicularis Lamk. syn. *P. odoratissimus* Linn. f.; *P. tectorius* auct., *sensu lato*, non Soland ex Parkinson *sensu stricto* THE SCREWPINE

Beng–*Kewa-kanta, keya;* Guj–*Kewoda;* Hindi–*Kewda;* Kan–*Talemara;* Mal–*Kaida;* Mar–*Keora;* Tam–*Tazhai;* Tel–*Ketaki; mogali* (male).

Habit—A densely branched, bushy shrub or small tree, rarely erect. *Stem*—up to 6 m, supported by stilt-roots. *Leaf*—glaucous-green,

Pandanus fascicularis

0.92–2.5 m × 3.0–9.0 cm, ensiform, caudate-acuminate, coriaceous, with spines on the margins and midrib. *Flower*—spadices of male and female flowers; June–October, but sometimes during December-January and April–June; male 25–50 cm long, enclosed in a long, white, fragrant, caudate-acuminate spathe; female-solitary, 5 cm in diam. *Fruit*—oblong or globose syncarpium, 15–25 cm in diam, yellow or red.

Distribution and Ecology—Very common on coastal regions, river-banks, canals, fields, ponds, etc.; also in the Andaman Islands; also cultivated in different parts for ornament. Prefers well-drained, fertile soils. Resists salts.

Cultivation/Regeneration—Different forms are cultivated for different purposes. Can be propagated from stem-cuttings, offsets or division of the suckers; planted at 3–7 m during June–August. Flowering starts 3–4years later. Generally yields 100 inflorescences a year.

UTILIZATION

Reclamation—A good soil-binder, forms large thickets along roadsides, borders, banks of rivers, canals and marshy areas and ponds and controls erosion from wind and water. Suitable to reclaim coastal saline areas and sand-dunes and rocky sand-dunes and as shelterbelts and windbreaks in controlling coastal sand-drifts.

Others—Bud: Eaten under the name of cabbage; tender floral leaves also eaten raw or cooked with various condiments;used to flavour ice-creams and sherbets. *Leaf:* Employed for covering huts, for making mats, sacks, cordage, hats, baskets and other fancy articles, and umbrellas; yields a useful fibre, suitable for strong ropes and brushes. Suitable for paper-making. *Root:* Used for brush- and basket-making. *Inflorescence:* Valued for its fragrance and for decoration in hair; contains an essential oil; collected early morning, but storage reduces the quality of oil. Ripe spadices yield an essential oil known as OIL-OF-KEWDA (0.1–0.3%) (Tel–*Mogalinoone*), used as hair-oil either alone or mixed with jasmine-perfumed sesame oil. Used in soaps, cosmetics, bouquet, lotions, snuffs, hair-oils, incense-stick, and for flavouring betel-leaf, tobacco and scenting clothes. *Kewda-attar* and *Kewda*-water are also popular. Scented water is used in syrups, soft drinks and foods. Useful as stimulant, antispasmodic, and in headache and rheumatism. *Fruit:* Pulp eaten. *Seed:* Reported to be edible, but causes irritation in mouth.

P. furcatus Roxb. (Bombay–*Ran-keura*) is a small, gregarious tree, 3–9 m/47 cm, with long, linear leaves possessing spines, inodorous yellow inflorescence and solitary, orange-red, variable-sized fruit, found in Sikkim, at 600–1500 m, in West Bengal, Assam, Meghalaya and Nagaland and in Konkan and Karnataka. Forms dense impenetrable thickets in marshy places and near watercourses. May be useful for reclamation. Leaf used for mats; wood for floats.

PANICUM Linn. (*Poaceae*)

Annual or perennial grasses; tropical and warm-temperate parts of the world; 15 spp in India.

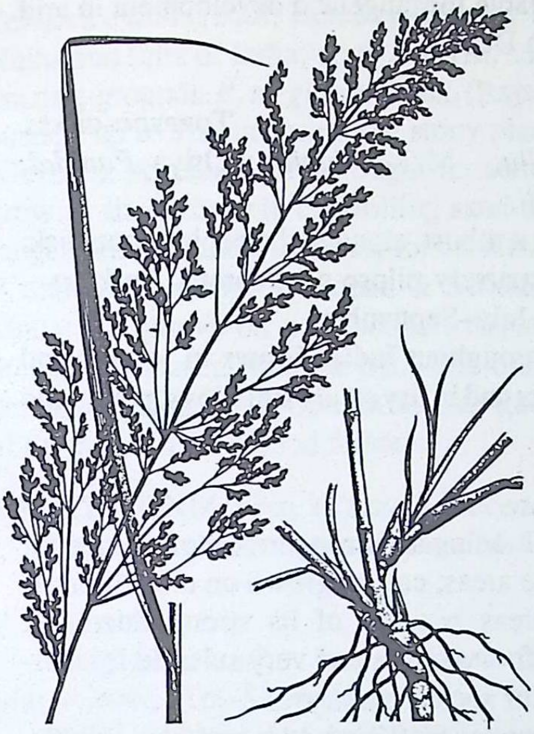
P. antidotale Retz. BLUEPANIC

Guj–*Dhusghas;* Hindi–*Gunara;* Tam–*Nassiampillu.*
Bombay–*Male;* Punjab–*Gharam;* Rajasthan–*Bangagll.*

Habit—A perennial grass, with a thick, creeping rootstock. *Culm*—up to 2.0 m, with solid, woody internodes. *Leaf*—up to 60 cm × 20 mm. *Flower*—in effuse panicles, 15–23 cm long. *Flowering & Fruiting*—August–September.

Distribution and Ecology—Punjab, Kashmir and Upper Gangetic

P. miliaceum



Panicum antidotale

plains and southwards extending up to Kerala. Grows in semi-arid regions, dry river-beds and in deserts, but susceptible to waterlogging. Drought-resistant and winter-hardy. Also grows on moist, fertile, sandy-loam soil, and saline-alkaline lands and mineral soils.

Cultivation/Regeneration—Mainly propagated from seeds; also from root-slips and setts. Seed (4–13 kg/ha) is sown broadcast or drilled at the commencement of rainy season and can be harvested in 3 months, but propagation for 6–8 months is recommended. Responds to manuring and irrigation. Optimum performance is on moist, fertile, sandy-loam soils. Intercropping with pulses increases the total biomass, economizes on nitrogen and enhances the long-term productivity of semi-arid regions. Withstands cutting and grazing.

UTILIZATION

Reclamation—Recommended for saline, alkaline and deep sandy soils and sand-dunes, gullies and ravines, and rangelands. An excellent sand-binder, grows in clumps, in bushes and hedges and is very useful for erosion-control on flood-plains and as windbreak, and for soil-conservation in Rajasthan desert. Has a remarkable power of recovery from cutting and grazing. Also recommended for social forestry.

Fodder—Suitable for grazing to all animals at all stages (crude protein, 7.26%). Highly productive and suitable for rangeland development in arid and semi-arid regions of the Indian Desert.

P. repens Linn. TORPEDO-GRASS

Beng–*Bamdu;* Kan–*Sonti-hullu;* Mal–*Inchipillu;* Oriya–*Panidal;* Tam–*Thineipillu;* Tel–*Laddagaddi.*

Habit—A perennial grass with a robust, elongated creeping rootstock. *Culm*—erect, 70–150 cm. *Leaf*—sparsely pilose or glabrous. *Spikelet*—3–2 mm. *Flowering & Fruiting* —July–September.

Distribution and Ecology—Throughout India. Grows in aquatic and semi-aquatic conditions, backwaters and in dry sandy situations, plains and ghats; becomes a weed.

UTILIZATION

Reclamation—Can withstand flooding and drought; recommended for ravines, waterlogged and mangrove areas; can be grown on metalliferous soils for reclamation of mined areas because of its strong rhizomes. Reported to be a good grass for turfs and lawns and very suitable for soil-conservation. Also recommended for social forestry.

Fodder—Both green (crude protein, 8.49%) fodder and hay are relished by cattle; possesses high nutritive value.

Others—Can be blended with long-fibred woodpulp.

P. coloratum Linn. (Uttar Pradesh–*Makenakau*), a native to East Africa, is a stoloniferous perennial, introduced into India. A soil-binding grass, grows on wet, often waterlogged, areas up to 2000 m. A good fodder (crude protein, 3.45%)for goats.

P. maximum Jacq. syn. *P. jumantorum* Pers. (GUINEAGRASS; Guj–*Ginighas;* Kan–*Ginihullu;* Mar–*Ginigawat;* Tam–*Ginipillu;* Uttar Pradesh–*Guinit*) is a tall, perennial grass, up to 3 m, native to tropical Africa, introduced into India, suitable to many types of soils except on prolonged waterlogged soils; can be grown on coalspoils with high *p*H and low nitrogen and phosphorus. Yields fodder (crude protein, 7.7–17.39%); rich in minerals.

P. miliaceum Linn. (COMMON OR PROSOMILLET; Beng & Hindi–*Cheena;* Guj–*Chino, vari;* Kan–*Baragu;* Mar–*Varo;* Tam–*Panivaragu;* Tel–*Varagulu*), found in Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Madhya Pradesh, Bihar, Uttar Pradesh,and Haryana and Punjab; suitable to any type of soil including poor and thin types. Yields green fodder (protein, 2%) and grains (protein, 10.18%; starch, 52%; oil, up to 7%). *P. trypheron* Schult. (Kan–*Samaihullu;* Tam–*Samaikarunai;*

Tel–*Adavisathagaddi;* Bombay–*Bhatur;* Uttar Pradesh–*Mijhri*), found on plains and hills of India, up to 1700 m, suitable to cover waste places and grazing-grounds. *P. turgidum* Forsk. (Rajasthan–*Murutaghas*) forms dense bushes, up to 1m, in desert and stony places of Rajasthan and Saurashtra (Gujarat). A remarkably drought-resistant grass, binds sand. Suitable to grow as shelterbelts in controlling sand-drift areas, mineral soils and on rangelands. Valuable as fodder for camels. Grain also eaten in some places. *P. sumatrense* Roth ex Roem. & Schult. syn. *P. miliare* Lam.(LITTLE MILLET) is grown on poor soils. *P. virgatum* Linn. syn. *P. glaberrimum* Steud., introduced from the USA into India, is a vigorous, sod-forming, perennial grass, 90–150 cm in height. Recommended for the reclamation of ravines. Yields a good fodder.

PARKINSONIA Linn. (*Caesalpiniaceae*)

Trees and shrubs; warmer parts of America and Africa; 1sp in India.

P. aculeata Linn. JERUSALEM-THORN

Beng–*Balati kikar;* Guj–*Pardeshi baval;* Hindi–*Vilayati babul;* Mar–*Adanti;* Tel–*Seematumma.*

Habit—A large, fast-growing, spinous shrub or a small tree, up to 15m. *Bark*—Green or brown, thin, smooth. *Leaf*—primary rachis bipinnate; leaf-buds in a short spine besides spiny stipules; secondary rachis modified into a green and much-flattened, 15–30 cm phyllode, 1–3 pairs, on which long or small, ovate or oblanceolate leaflets or pinnules present. *Flower*—yellow, fragrant , ornamental, in axillary racemes. *Fruit*—slender, moniliform, 4–7-seeded pod, up to 10 cm. *Seed*—oblong, dark-brown, 12,000–13,000/kg; March–April; germination 30–70%; needs immersion in boiling water.

Distribution—Introduced into India, almost naturalized throughout the drier parts of India, and commonly cultivated as a hedge, and for ornament.

Cultivation/Regeneration—Direct sowing of seeds or through transplants and root- or shoot-cuttings.

UTILIZATION

Reclamation—Very useful for afforestation of dry sand-dunes, arid and semi-arid areas, gullies and ravines and particularly in the outer rows of arid zone, shelterbelts and windbreaks. Frequently grown for its showy flowers, and also as a hedge. Recommended for social forestry.

Fuel—Used as firewood; makes a good charcoal.

Fodder—Young branches (leaf: crude protein, 7.5%) lopped for goats and sheep.

Others—Plant: All parts possess antipyretic, diaphoretic and abortifacient properties. *Bark:* Yields a fibre; suitable for mixing with other pulps for paper. *Seed:* Edible. Yields mucilage (28%) and a fatty oil (1.65%).

PARTHENIUM Linn. (*Asteraceae*)

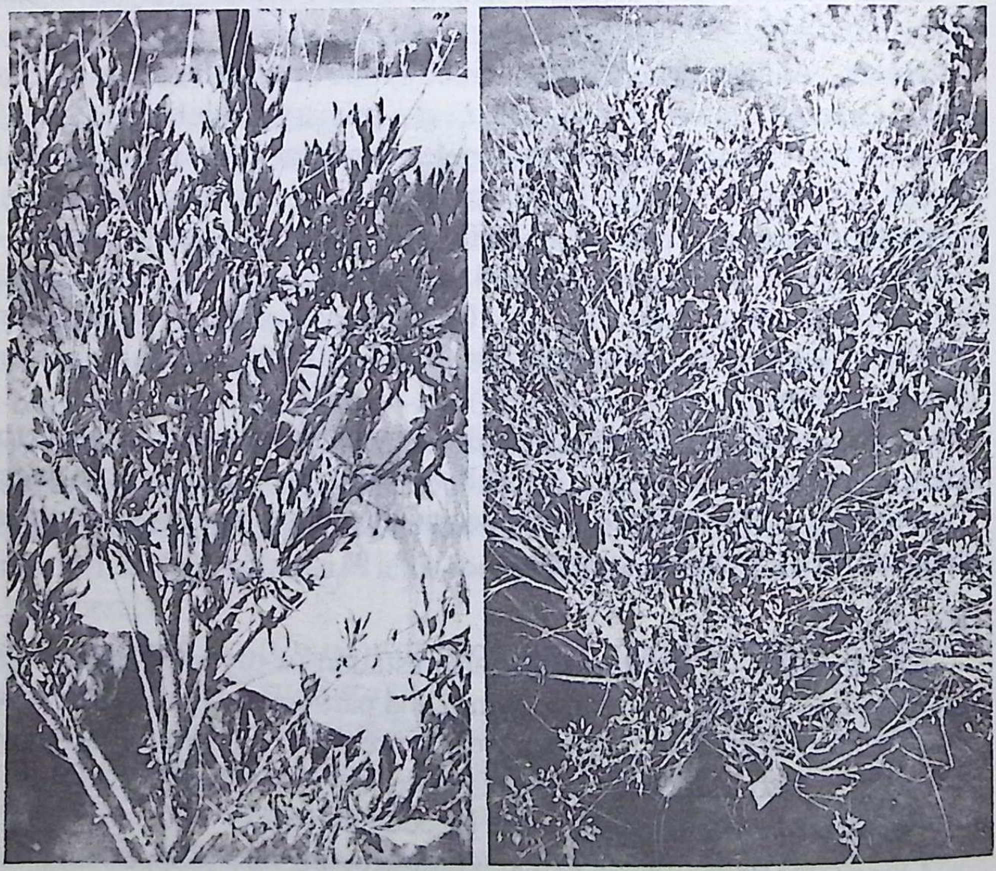
Herbs or shrubs; North America and the West Indies; 2 spp in India.

P. argentatum A. Gray GUAYULE

Habit—A small, bushy, much-branched, silvery pubescent shrub, up to 1m. *Leaf*—lanceolate to lanceovate, oblanceolate, up to 5 cm long, entire or few-toothed, silvery-canescent. *Flower*—blue, in many heads, in close corymbs on a long peduncle. *Fruit*—achene, with 2 or 3 divergent, papper-like awns.

Distribution and Ecology—Native to North-Central Mexico and southern Texas, introduced into India. Grows in arid and semi-arid regions and marginal lands with annual rainfall less than 250 mm.

Cultivation/Regeneration—Can be grown from direct sowing or from



Parthenium argentatum

transplanting nursery-raised seedlings; requires not much water, but needs the sunlight, and low temperatures at night. Can live for 30–40 years. *Fusarium* sp attacks roots during rains; free from pests. Tops can be harvested every 2–6 years for rubber, leaving a portion for regeneration.

UTILIZATION

Reclamation—Suitable and recommended for afforestation of the desert-areas and marginal lands.

Others—Stem: Yields a rubber, which can be substituted for that of *Hevea* for articles, such as tyres, footwear, belting and hose. A two-year-old plant produces at least 10% rubber by dry weight, and can be increased with chemical stimulants at the early stages up to 300%. Reported to be a possible petroplant. *Leaf:* Yields an essential oil.

PHOENIX Linn. (*Arecaceae*)

Tall, dioecious or sometimes shrubby palms; tropical and sub-tropical parts of Africa and Asia; 7 spp in India; a few introduced.

P. dactylifera Linn. THE DATEPALM

Beng, Guj, Hindi & Mar–*Khajur;* Kan–*Kharjura;* Mal–*Ittappazham;* Oriya–*Khorjjuri;* Tam–*Perichchankay;* Tel–*Eeta, kharjooramu.*

Habit—A tall palm, up to 36 m. *Stem*—covered with persistent petiole-bases, usually surrounded by a mass of off-shoots or suckers. *Leaf*—in open crown, pinnate, keeled, lower pinnae modified into spines. *Flower*—small, yellowish, in branched spadices; March–April. *Fruit*—oblong, drupe, 2.5–7.5 cm long, reddish or yellowish-brown when ripe; August–October. *Seed*—cylindric, hard, with a longitudinal furrow, 2.5–3.0 cm long; 750/kg; germination 70–100%.

Distribution and Ecology—Cultivated or occasionally found in dry districts of Gujarat, Rajasthan, Punjab, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh and Karnataka. Can be cultivated in arid and irrigated regions of North-West India. Palm is exacting in its climatic requirements and needs prolonged, high night-temperatures, mild frost, low relative humidity and very little rain (12.5 cm) during flowering; established plants can withstand up to 50°C summer temperature. Highly tolerant to excessive irrigation, even to floods, sandy, loamy or clayey soils, but soil should be well-drained; tolerates highly alkaline and saline soils. Sandy loam of good depth and water-holding capacity is the best.

Cultivation/Regeneration—From seed or off-shoots. Commercial crop is always propagated from rooted off-shoots of axillary origin, chiefly during the early life of the palm; planted either during February–April or August–September at 5–8 m × 5–8 m in India. Responds to manuring of 50–60 kg farmyard-manure or 1–2 kg ammonium sulphate, applied in two doses, during January–February and August–September every 2–3 years; cowdung (45 kg) may also be given before the spring. Green-manuring with leguminous cover-crops in the early stages is good. Needs plenty of moisture but not prolonged waterlogging. Pruning of leaves should be done if necessary but dead ones should be removed. Thinning increases the size of fruits. Can be interplanted with wheat, barley, vegetables, leguminous fodders and pulses during early stages, and low-growing fruit-crops, such as grapes, pomegranates, figs, peaches, apricots, oranges, etc. If grown from seed, all plants or at least half may not be females and those females which grow bear fruit of variable quality; also takes 4–10 years to determine the sexes and the quality. Hence, vegetative propagation is preferred.

UTILIZATION

Reclamation—Can be cultivated on alkaline and saline soils, arid and semi-arid and irrigated regions of North-West India, as it tolerates more alkali or salt than most other plants.

Timber—Houses, bridges, water-conduits, etc.

Fuel—Lower thicker portion of petioles used as fuel.

Fodder—Powdered seed (pectin, 6.3–9.2%) or water-soaked ones is given to camels, goats, sheep and horses; can be substituted for barley in chick-rations.

Others—Leaf: Bud eaten raw or cooked as a vegetable. Widely used for thatching, mats, fans, baskets, ropes, etc.,petioles for light walking-sticks, crates, boxes and fishing-floats. Used as manure. Petiole yields a fibre used for cordage and substituted for coir. *Spathe:* Yields an essential oil which possesses antimicrobial properties. *Fruit:* Eaten fresh or processed (protein, 2.5%); rich in sugars (up to 85%); contains several minerals and vitamins and tannins (0.8–1.8%). Pulp used to prepare delicious ready-to-serve drink and jams; and a type of honey is also prepared from them. Demulcent, expectorant, laxative and given in fever; immature astringent. Stalk used as brooms: *Seed:* A paste applied in eye-diseases. Roasted ones used as an adulterant to coffee and arecanut. *Sap:* Tree yields a sweet (sugar, 10%), pleasant-flavoured liquid with good nutritive value; jaggery (*gur*), sugar, and vinegar made out of it; can be converted into alcohol. A potential source for refined sugar.

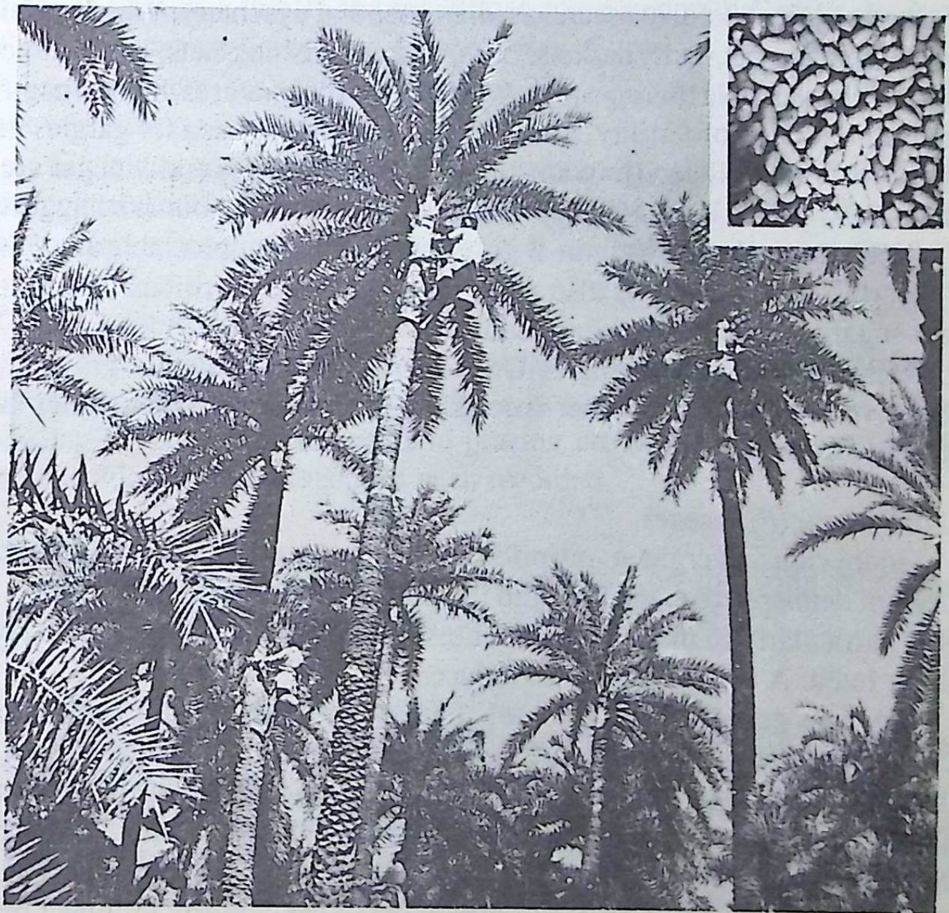
P. sylvestris Roxb. THE WILD DATEPALM

Beng & Hindi–*Khajur;* Guj–*Kharak;* Kan–*Ichalu;* Mar–*Shindi;*

Oriya–*Khajuri;* Tam–*Icham;* Tel–*Pedda-eeta.*

Habit—A graceful palm, 10–16 m. *Stem*—covered with persistent bases of petioles, with a large crown. *Leaf*—compound, greyish-green, with a few, short spines at the base, 3.0–4.5 m long, petiole orange-yellow up to pinnae, sometimes extending beyond pinnae: pinnae numerous, linear, 15–45 cm long, ending in short-hard point. *Flower*—in spadices, small fragrant: male white; female greenish; appear at the beginning of summer. *Fruit*—oblong-ellipsoid, orange-yellow drupe, 2.5–3.2 cm long; September–October. *Seed*—deeply grooved, rounded at the ends, *c* 1.7 m long.

Distribution and Ecology—Common in many parts of India, either wild or cultivated, up to 1500 m. Grows in varied climates and on several types of soils including sandy and rocky areas, but prefers moist, alluvial soils and not too heavy and clayey.



Phoenix sylvestris

CULTIVATION/REGENERATION

Natural Regeneration—Freely takes place from seed and the young plants are not generally grazed.

Artificial Regeneration—Seed may directly be sown in May in the nursery and transplanted in rains in prepared soils in third year. Yellow leaves are removed. A few diseases and pests have been recorded.

UTILIZATION

Reclamation—Recommended for stabilization of soil, as shelterbelts in controlling coastal sand-drift areas, arid sands and for agroforestry on field-bunds and wateredges.

Timber—Water-conduits, construction of houses, bridges, piers; and tentpegs.

Fodder–Leaf sometimes lopped.

Others—Leaf: Leafbud and the inner portion of the stem eaten in times of scarcity; juice useful in ascariasis, diarrhoea and dysentery. Widely used for thatching, mats, fans, baskets, bags, brooms, fishing-nets, etc. Petiole yields a fibre suitable for ropes, etc. *Root:* Used in haematurea, menorrhagia and for promotion of fertility. *Stem:* Decoction of bark used for gargles in pyorrhoea. *Fruit:* Eaten (protein, 1.2%); jams and jellies and vinegar are made. *Sap:* Yields a refreshing sweet drink and a good source of sugars (11.01%), minerals and vitamin-B group and contains appreciable amount of ascorbic acid; jaggery is also made which is more nutritious than that from sugarcane. Fermented into toddy.

P. paludosa Roxb. (Beng & Oriya–*Hital;* Tel–*Hintalamu*) grows in mangrove regions. A few other species are grown for ornament either in groups or avenues.

PINUS Linn. (*Pinaceae*)

Monoecious, evergreen, resiniferous trees, commonly known as PINE; Northern hemisphere extending into the South across the equator in Indonesia, particularly in moist and very moist areas, chiefly in the hills; 5spp wild in India. A few have been introduced.

The pines generally grow in cool climate and even grow on sandstone rocks or bare rocks as *P. kesiya* Royle ex Gord. syn. *P. insularis* Endl. (KHASIPINE) and often form pure forests as *P. roxburghii* between 600 and 1500 m. These pines yield edible seeds, oleo-resin, leafwool, etc., and are wind-firm. Generally not felled for timber where edible seeds are collected. *P. roxburghii* is the main source of turpentine in the country, followed by *P. wallichiana;* its timber is very widely used for construction, carriages, pulp, etc. Even *P. wallichiana* A.B. Jackson syn. *P. excelsa* Wall. ex D. Don; *P. griffithii* McCleland (BHUTAN-PINE, BLUE-PINE) forms pure patches, helping the soils to stabilize. Recommended for social forestry.

P. gerardiana Wall. CHILGOZA-PINE

Hindi–*Chilgoza;* N-W Himal–*Chiri, gunobter, prita.*

Habit—A small to moderate-sized tree, with branches somewhat ascending and generally not whorled, 24 m/3.5 m. *Bark*—grey, exfoliating in irregular, thin flakes. *Leaf*—needle-like, 5–10 cm long, stiff, dark green partly persisting for 3–4years, in clusters of 3. *Flower*—May–June: male cone 7.5–13.0 mm long; female cone oblong-ovoid, 15–23 cm×10–13 cm when ripe; scales woody, reflexed; cone ripens during September–October of next year. *Seed*—cylindrical, pointed, dark brown, with a rudimentary wing, 2.0–2.5 cm long, endosperm oily; 3000–3200/kg.

Distribution and Ecology—In the inner arid valleys of the North-West Himalayas from Garhwal westwards, at 1800–3000 m, forms gregarious, more or less open, forests and sometimes associated with *Cedrus deodara, Fraxinus xanthoxyloides* and *Quercus ilex*. Grows on dry, barren, rocky hillsides having shallow soils, with a 370–750 mm rainfall and heavy snowfall during winter.

Silvicultural Characters—A light-demander. Hardy and withstands drought and cold. Stunted and gnarled on exposed situations but these trees bear more cones than the shapely ones. Wind-firm.

CULTIVATION/REGENERATION

Natural Regeneration—Greatly suffers from extensive collection of cones for edible seeds, indiscriminate grazing and browsing. Rotation, closing for collection of seed and grazing are best suited for successful regeneration. A few pests have been recorded.

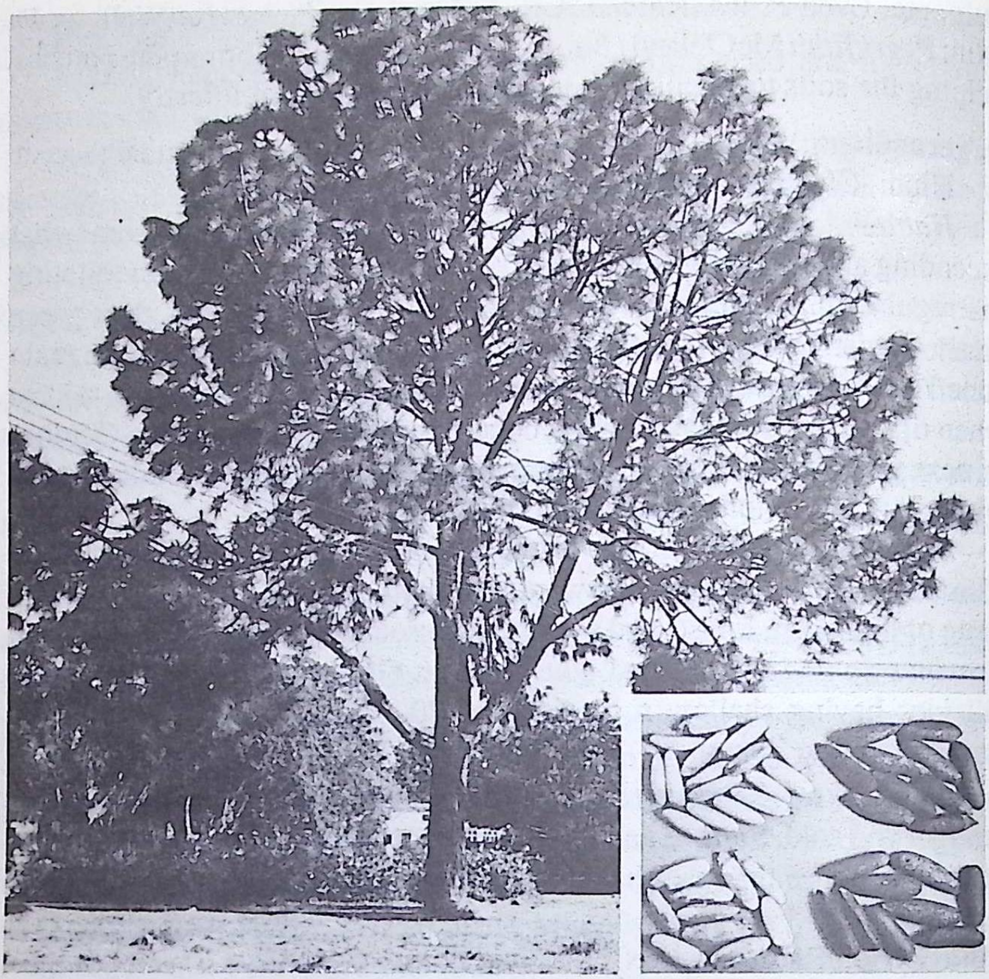
UTILIZATION

Reclamation—Recommended for growing on the soils mentioned above and for reclamation in the inner hills which should otherwise be bare rocks.

Timber—Rarely felled; burnt for torches and as fuel.

Others—Bark: Made into baskets and buckets. Yields an oleoresin from which a good-quality turpentine oil is obtained (35 l/100 kg). *Seed:* Ripe kernel (protein, 15.9; fat, 49.9%) eaten raw or roasted; valued as a dessert especially in India. Carminative, stimulant and expectorant; yields an oil used for dressing wounds and ulcers.

P. caribaea More. (CARIBBEAN PITCH-PINE), introduced into Assam and



Pinus roxburghii P. gerardiana

Dehra Dun, suitable for growing on mine-spoils, particularly tin. *P. elliottii* Engelm., successfully introduced into Madhya Pradesh, grown for reclaiming bauxite-mined areas.

P. halepensis Mill. (Aleppo Pine), native to Mediterranean region, introduced into Kashmir, is extensively grown as wind-break and for soil-conservation and sand-fixation. Bark contains tannins (11–16%). Yields pulp suitable for paper.

P. merkusii Jungh. & de Vriese (Tenasserim Pine) is a tree, up to 30 m, recommended to cover the eroded hillslopes and other critical soils to check erosion and for reclamation. Timber used for general construction and indoor-work. Wood-chips contain gum-resin which yields turpentine oil (13%). *P. patula* Schlecht. & Champ. (Spreading-leaved Pine) is up to 18 m (seed, 88,123–132,275/kg; germination 21–50 days, 30–60%), recommended for grassy blanks, moist and very moist areas. Yields pulp suitable for kraft-paper and newsprint. *P. roxburghii* Sarg. syn. *P. longifolia* Roxb. (CHIR-PINE), introduced into Madhya Pradesh to reclaim the bauxite-mined areas, found to be successful. Timber is highly useful. *P. taeda* Linn. (LOBOLLY PINE), native to the USA, introduced into Himachal Pradesh, is suitable for reforestation of acid spoils, eroded oil-filled sites. Suitable for maximizing organic matter in soil and also to check erosion. Timber utilized for pulp and ship-building. A source of American turpentine oil. *P. thunbergii* Parl. (JAPANESE BLACK-PINE), native to Japan, successfully introduced into Samundar and Takhdah in Himachal Pradesh, is resistant to uprooting and can, therefore, be used for checking landslides and stabilization of sand on new and existing dunes. Timber useful for heavy construction, interior finish, boxboards, sleepers, etc.

PITHECELLOBIUM Mart. (*Mimosaceae*)

Trees and shrubs; chiefly in the tropics of Asia and America; 10 spp in India.

P. dulce Benth. QUMACHIL, MADRAS-THORN, MANILA-TAMARIND

Beng–*Dekhani babul;* Hindi–*Vilayati imli, jungle-jalebi;* Kan–*Kottampuli; seemae-hunase;* Mal–*Korukkapuli;* Mar–*Vilayati chinch;* Tam–*Kodukkaapuli;* Tel–*Seemachinta.*

Habit—A small to medium-sized, fast-growing, evergreen, spiny tree, up to 18 m. *Bark*—smooth, grey with yellowish-white lenticels. *Leaf*—bipinnate: pinna 2; pinnules 2 in each pinna, obliquely ovate-oblong, 1–4 cm long; stipules modified into spines. *Flower*—small white, in dense, globular, heads, 1 cm in diam; January–February. *Fruit*—reddish-brown, curved or twisted, constricted pod; 6–10-seeded; 10.0–15.0 cm × 1.0–1.5 cm; April–June. *Seed*—shining black, enveloped in pink to whitish, pulpy, edible aril; 6700–25,700/kg; germination 35 days, 45–100%; needs soaking in water.

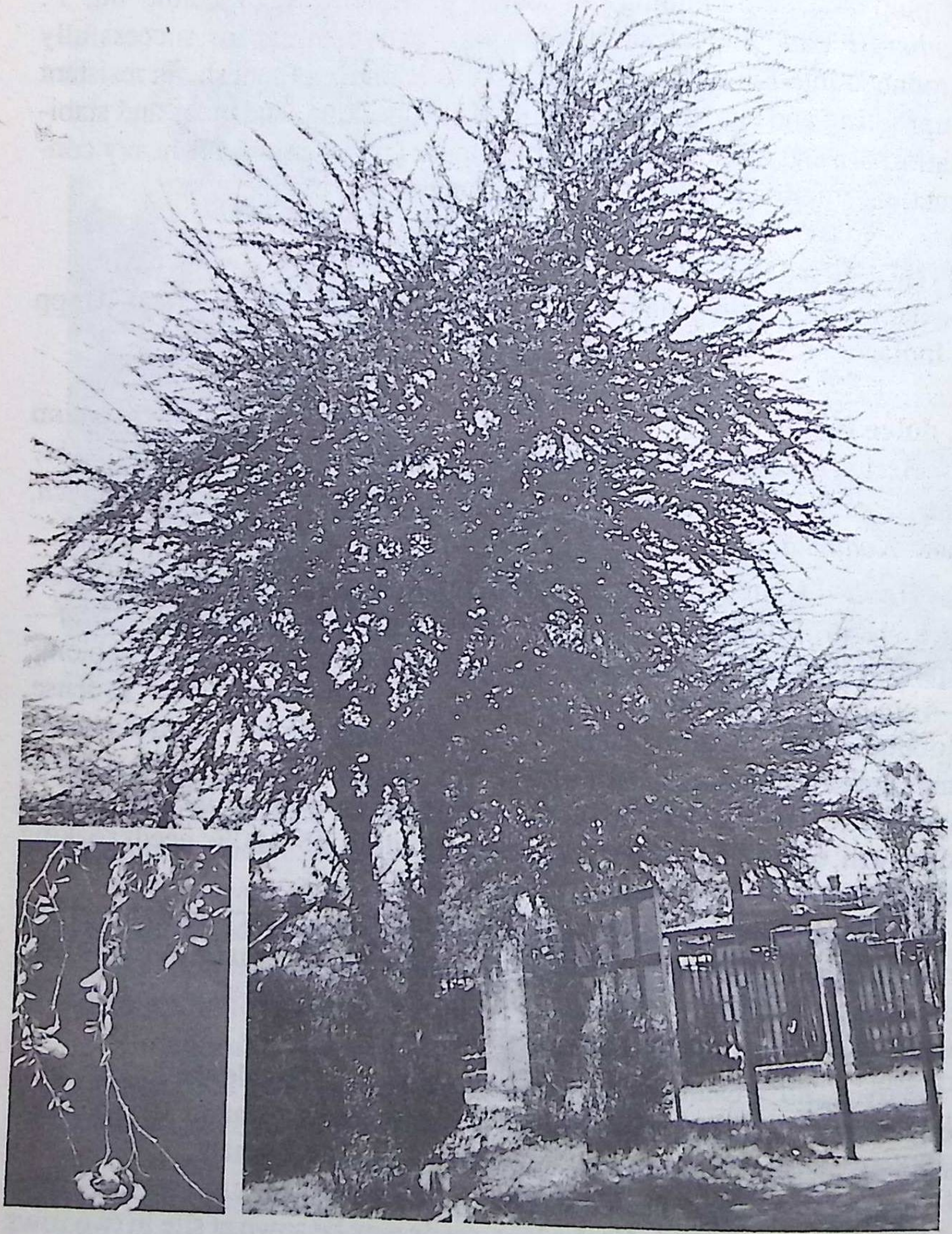
Distribution and Ecology—Native to tropical America, introduced into India, cultivated throughout the plains and in the Andamans. A hardy tree, grows even in waste- and denuded lands, ravines, pure sandy soil and on seacoast with its roots in brackish or salt water.

Silvicultural Characters—Tree tolerates considerable shade. Drought-resistant but susceptible to frost. Vigorously coppices and can withstand any amount of pruning or lopping, or browsing by animals.

Cultivation/Regeneration—Can be propagated through seed, branch-cuttings or transplanting. For hedges, seeds may be sown at site in two rows 30 cm apart with a spacing of 15 cm. By regular trimming, almost impenetrable fences can be grown. Attacked by a leafspot and many defoliators and borers. Lac insect has also been recorded on this plant.

UTILIZATION

Reclamation—Can be grown to reclaim saline and alkaline soils, waste- and denuded lands, pure sandy soils and on seacoast. Recommend-



Pithecellobium dulce

ed to grow as shelterbelts, windbreaks and on roadsides and in social forestry. Mostly grown for hedges, fuel and as windbreaks, and for fruits. Fixes nitrogen. Leaf used for green-manuring.

Timber—General construction, packing-cases; fence-posts; cart-building; and agricultural implements.

Fuel—An excellent firewood.

Fodder—Leaf (crude protein, 29.0%) given to sheep, goats, horses and cattle. Fruit also given as fodder for cattle, sheep, goats and other livestock. Seed cake can be given as feed.

Others—Bark: Yields tannins (up to 37%), used to tan sole-leather and kips and pectin (1.4%); good substitute for wattle-bark. Yields an yellow dye. Astringent, used in dysentery. Causes dermatitis and inflammation of eye. *Leaf:* Astringent; contains an insulin-like principle. *Fruit:* Pulpy aril (protein, 0.7%) astringent, sweet and eaten. Contains several minerals and vitamins and essential amino acids. A beverage similar to lemonade is made. *Seed:* Eaten raw or in curries (protein, 17.6%). Yields an edible oil and can be substituted for oil of kapok and groundnut. Contains saponin which possesses spermicidal, anti-inflammatory and antioedema properties.

POPULUS Linn. (*Salicaceae*)

Deciduous, dioecious trees, commonly known as POPLAR, ASPEN and COTTONWOOD; chiefly in North temperate zone with some species in subtropical region; 10 spp in India; a few species and several inter- and intraspecific hybrids have been introduced.

The delimitations and names of the species in this bewildering genus are not clear, as cross-fertilization is very common. Several natural hybrids of ancient origin exist and new hybrids are constantly evolved. There are three main groups: (*i*) White poplars with smooth, white or grey bark; (*ii*) Black poplars with dark, fissured bark on ageing; and (*iii*) Balsam poplars which exude aromatic resins.

Generally, these species grow on sandy to riverbeds, clayey loam; and also on alluvium. These also grow near watercourses, on river- and canal-banks, irrigation-channels and marshes, and also where the watertable is high. Most of the species planted for productive forestry are exacting in their requirement of soil and water, growing well on deep, rich loams, well-aerated and well-drained, with abundant but not stagnant water; some species, such as *P. alba*, are, however, less exacting and, therefore, planted for reclamation and conservation.

Trials of some exotics in India indicate that they require a subtropical and temperate climate and sufficient moisture in soil with a high watertable and light. They can be grown alongside watercourses, and in mixed forests with other species; they also do better with irrigation. In *terai* region of Uttar Pradesh, Bihar and West Bengal and the sub-Himalayan tracts of Himachal Pradesh, poplars are cultivated. Large-scale plantations to meet the demands for timber and fuel are being created in India, particularly in Uttar Pradesh.

Many poplars naturally regenerate from seed and suckers, and also from coppice-shoots. Artificial regeneration can be done through transplanting seedlings or rooted cuttings. Generally, seed is employed for the evolution of clones, and for the species which do not easily root. The fresh, dried seed is sown in beds, mixed with fine sand, and irrigated. Mulch is provided. Seedlings in dense sowings are pricked out. They may be sprayed with nutrients. The seedlings reach 50–100 cm in a year. Later cultural practices are similar to those of cuttings.

Populus spp.

For plantations, vegetative propagation is preferred. One-year-old stem- or branch-cuttings (25–30 cm/3–4 cm) are either directly planted in the field or nursery-raised. These are planted 80–100 cm apart in January with one bud above the ground and irrigated. Fertilizer in 3 doses in July, August and September and 3–4 weedings improve the growth. They respond well to intensive cultural treatment and can be planted very close: Weeding is essential at the time of rooting. Spacing depends upon utility. Close spacing is given if exploited at younger age; wide spacing for large quantity of timber. Dense plantations protect the soil from erosion and provide litter. The recommended density is from 500 to 1000 trees/ha.

Populus spp are relatively fast-growing and are light-demanders. They are hardy and need specific silvicultural practices in plantations, which depend upon the utility. Only careful pruning or trimming of the crown and branches from the time of planting and during its growth yield a stem of the best form. Stands should be cleared of diseased, undesirable and unsuitable trees. Thinning and felling give space and light; at times, gap-filling may also be needed.

Poplars are multi-useful from soil-protection to timber; they can also be grown on partially reclaimed alkaline soils in sub-tropics. They are planted for intensive cultivation with farm- and forage-crops outside the forests or the young stands are inter-planted with crops since the crowns are thin. They are also planted to improve the natural stands, and can be planted in grasslands, on borders and bunds, 1–2 m away from water. The less-exacting species are more successful in conservation work on eroded or unstable soils, and in shelterbelts, windbelts and on roadsides. A few exotics are good for reclothing the cold deserts in Himachal Pradesh and Jammu & Kashmir. Many species can be grown on mine-spoils.

These species are one of the few leafless trees for 3-4 months and ideal for agrisilviculture and social forestry. In *terai*, these are intercropped with paddy during the rainy season and with wheat during the winter. In Jammu & Kashmir, leguminous fodder, maize and other high-yielding grasses have been found to be well-suited as intercrops.

The timber from these species is large, light and soft, and utilized for buildings, pulp and paper, board-making, veneers, match-splints, boxes, woodwool, sabots, woodfloor, straw-work, orthopaedic work, musical instruments, agricultural implements, artisan work, and in electrical and chemical industry, and as fuel.

Leaf provides fodder, and litter to soil.

P. alba Linn. WHITE POPLAR

N-W Himal–*Chitta bagnu, jangli-frast;* Kashmir–*Fras*.

Habit—A variable, medium-sized to large tree, generally with full crown and thin, cylindrical, downy shoots. *Stem*—more or less flexuous, sometimes very straight, with ramified branches, cylindrical. *Bark*—greyish, becomes whitish, rough and furrowed on old trees. *Leaf*—variable in size and shape, 5–10 cm long, sinuate or lobed, always with persistent, white tomentose beneath; on long shoot more or less lobed, fairly large; on short shoot always sinuate-lobed, narrowly elliptic to heart-shaped and suborbicular. *Flower*—small, in hairy catkins. *Fruit*—6 mm long capsule. *Seed*—minute, hairy.

Distribution and Ecology—Native from Central Europe to Central Asia, found in the North-West Himalayas, at 1200–3000 m; commonly grown in avenues. Found generally in hot and dry regions and in areas with certain degree of salinity. Thrives best on deep-moist soil; sometimes found on hot and dry slopes with shallow soil, commonly seen in ravines in Kashmir, marshy habitats along mountains, streams and canals, and in avenues and hedges.

Silvicultural Characters—Extremely resistant to high temperature, and wind, but not that frost-hardy. Rootsuckering is vigorous, sometimes appearing 50 m away from the parent. Coppices well.

CULTIVATION/REGENERATION

Natural Regeneration—Seedlings spring up on newly exposed ground or on recent alluvial deposits in the beds of streams. Also rootsuckers help in regeneration.

Artificial Regeneration—Easily through stem- and root-cuttings or by transplanting suckers. After felling, coppice-shoots and rootsuckers also help in regeneration. Rate of growth fast.

UTILIZATION

Reclamation—Recommended for the afforestation of hot and dry slopes with shallow soils, cold deserts and also for preventing landslides; and soils with certain degree of salinity or water with salinity and other wastelands. Recommended for agroforestry. Suitable for growing on sulphur-mine heaps.

Timber—Cabinet-work, piano and violin parts, carriages, sabots, match-veneers, small turnery articles, woodwool; and pulp.

Fuel—Can be used as firewood.

Fodder—Cattle browse upon leaves.

Others—*Bark:* Used as antipyretic like quinine; contains salicine and populine which eliminate uric acid.

P. ciliata Wall. ex Royle HIMALAYAN POPLAR

Bengal–*Bangikat;* Jaunsar–*Biaon, piplas;* Kumaun–*Syan;* N-W Himal–*Bagnu, chelun, tilaunja.*

Habit—A fairly, fast-growing, moderate-sized to large-tree, up to 36 m/4 m. *Rootsystem*—strong, spreading, cuttings produce strong, thick lateral roots. *Stem*—clean bole of about 21 m. *Bark*—dark grey, with longitudinal fissures. *Leaf*—broadly ovate or ovate-lanceolate, with serrulate-crenate and ciliate margin, 7.5–18.0 cm long. *Flower*—small, in catkins. *Fruit*—ovoid capsule, 7.5–10.0 mm long. *Seed*—minute, hairy.

Distribution and Ecology—Found throughout the Himalayas, at 1200–3500 m; and also in the Aka hills of Arunachal Pradesh. Reported to be cultivated in Shillong (Meghalaya). Commonly found in the mixed broad-leaved oak and coniferous forests. Thrives best in shallow soils and in ravines on well-drained and porous soils. Sometimes occurs in pure patches on islands on the bed of streams.

CULTIVATION/REGENERATION

Natural Regeneration—Freely occurs through seeds during the early rains; seedlings spring up all over the exposed ground; and also through suckers.

Artificial Regeneration—Easily establishes through stem-cuttings or rootsuckers; rooted one-year-old cuttings give the best results. They easily root in shallow soils and produce several thick, strong, lateral roots. Can also be propagated through planting root-suckers. Owing to the small size of the seeds, raising the seedlings in nursery requires considerable care before transplanting.

Several fungi and many borers and defoliators cause considerable damage.

UTILIZATION

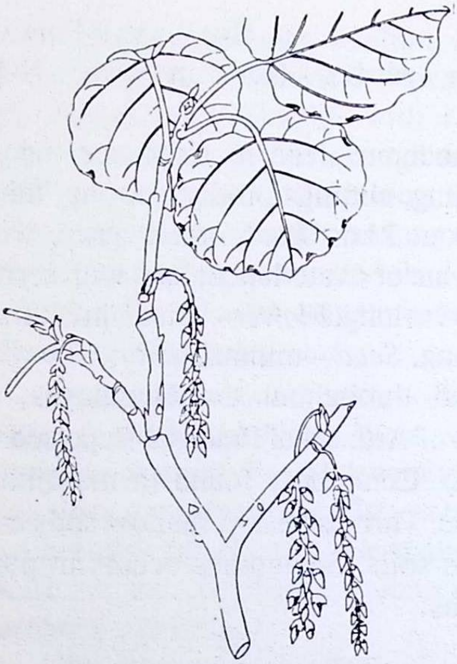
Reclamation—Useful for controlling soil-erosion in the hilly areas. Being a drought-plant, it can be grown on dry hillsides for afforestation of the unstable slopes and to prevent landslides. Also, commonly grown on the roadsides, especially in Kashmir. Easily roots in shallow soils where other tree-species cannot establish.

Timber—Fruit-crates, pencils, water-troughs, cricket-bats, turnery work, artificial limbs, veneers, match-boxes, splints; and paper-pulp.

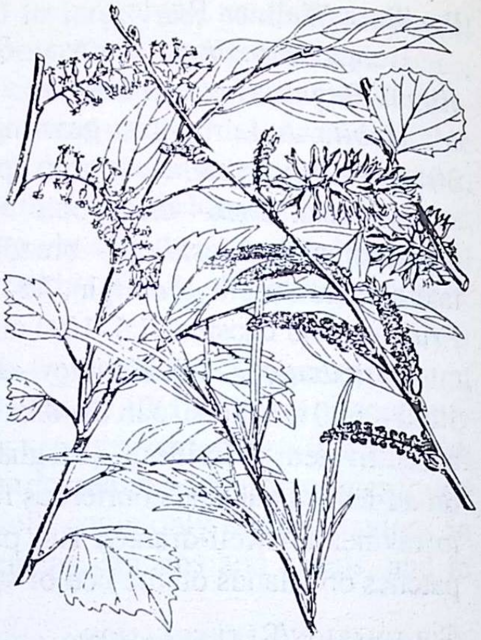
Fuel—Used as firewood in Ladakh.

Fodder—Leaf lopped for goats.

Others—*Bark:* Used as tonic, stimulant and blood-purifier.



P. ciliata



P. euphratica

P. deltoides Bartr. ex Marsh. Caroline Poplar, Eastern Cottonwood, Necklace Poplar

Habit—A fast-growing, tall tree, with a broad crown and viscid, brown buds, up to 30 m. *Stem*—usually straight. *Leaf*—ovate, truncate or somewhat cordate at base, tending to be triangular, glossy above, 17 cm long. *Flower*—male catkin 7–12 cm long, drooping with several stamens; female catkins 15–25 cm long when mature. *Fruit*—small capsule. *Seed*—small, hairy.

Distribution and Ecology—Native to North America, successfully cultivated in the plains of Uttar Pradesh, Punjab and Haryana. Generally grown on normal soils, but can also be grown on saline soils; does not prefer alkaline soils.

Cultivation/Regeneration—The species can very easily be rooted from cuttings. There are several clones in cultivation throughout the world.

For vigorous growth, 'G–3', 'G–48' and 'IC' from Australia, 'D–61', 'D–65', 'D–92' and 'D–121' from Mississipi (USA) are recommended for plains. A few more also have been recommended: '2492', '2503' '2504', '2562', '2653', '3297', '3298', '3367', '3651' and 'P 65/25'. Out of these, 'G–3' has shown excellent promise with 7–8 m growth in height and 22–26 cm in girth in the first year. 'D–92', 'IC–69/55' and '63/51' have proved successful in the plains of Uttar Pradesh, Punjab and Haryana.

UTILIZATION

Reclamation—Different clones are suitable for growing on sandy, clayey, slightly peaty and saline soils of the plains. Recommended for social-forestry plantation. It raises watertable wherever planted.

Timber—Match-splints, artificial limbs, cricket-bats; packing-cases, plywoods; and pulp.

Fodder—Lopped for animals.

P. × euramericana (Dode) Guinier

The various hybrids between *P. nigra* and *P. deltoides* are easily the most important for cultivation than the parents. The nomenclature of this large group of hybrids *P. nigra* × *P. deltoides* 'F_1', 'F_2', 'F_3', etc. is difficult and highly complex; hence, the international poplar commission had introduced for the whole of this group a collective name *P* x *euramericana* which includes all the hybrids of Euramerican origin.

These hybrids are extensively cultivated the world over. They can be grown for shelterbelts and roadside plantings and are suitable for the following types of soils: clay and compact soils, marshy peaty soils, sandy soils, acid soils, and soils having fairly high watertable.

From the point of view of vigorous growth, the clones '65/27', '72/58' and '75/58' have been found suitable and are worth growing in the plains. They attain 15–16 m height and 21–22 cm diam in 6 years. Other suitable clones for the hilly regions are 'I–214' and 'I- 021'. They can be cultivated by (a) single row-planting, (b) multiple row-planting, and (c) close-planting, out of which the last gives the maximum economic benefit. Rotation is usually 10 years.

UTILIZATION

Same as *P. deltoides*.

P. euphratica Olivier INDIAN POPLAR

Punjab & N-W Himal–*Bahan, bhan;* Ladakh–*Hotung, hondung.*

Habit—A medium-sized tree, with rather thick, more or less pubescent shoots, *c* 15 m/2.5 m. *Stem*—rarely straight and slender, often bushy. *Bark*—thick, rough, olive-green, longitudinally ridged and fissured, fibrous. *Leaf*—greyish-green, leathery, very variable, linear-oblong to ovate-rhomboid, 7.5–15.0 m, on long shoots triangular to rhombic with glands at the base of the blade; on short shoots, suborbicular, broad, strongly toothed at the apex. *Flower*—small, in catkins. *Fruit*—ovoid-lanceolate capsule, 7–12 mm long. *Seed*—minute hairy.

Distribution and Ecology—Found on the Sutlej banks in the Punjab and its feeders in the western Himalayas, ascending up to 4000 m in Ladakh and western Tibet. Typically gregarious, occurring pure or associated with other species, reaching the upper limits of the growth of trees, and is even found in the hottest parts in the plains, where it thrives in places having brief flooding. Found on rocky and hilly soils, soils having good supply of water; tolerates high degree of salinity and brackish water.

Silvicultural Characters—A light-demander. Frost-hardy. Produces vigorous rootsuckers. Coppices well and withstands pollarding for a long time.

CULTIVATION/REGENERATION

Natural Regenration—Occurs through seed or rootsuckers; seedlings spring up on fresh alluvial soils after the floods recede.

Artificial Regeneration—Through seed or cuttings not very successful. But rootsuckers and coppice-shoots are suitable. They are well-adapted for treatment under coppice or coppice-with-standards. Many defoliators, borers and gall-forming pests attack the tree.

UTILIZATION

Reclamation—Suitable for afforesting cold deserts and extremely arid areas, and hot and waterlogged areas even with brackish water and saline soils. Recommended for agroforestry.

Timber—Well-curbs, lacquer-work, turnery, matchboxes and -splints; plywood, cricket-bats, shoeheels, and bobbins.

Fuel—A good fuelwood (sapwood, 5019 kcal/kg).

Fodder—Leaf good for sheep, goats and camels.

P. nigra Linn. var. **italica** Koehne syn. *P. italica* Moench; *P. nigra* var. *pyramidalis* Spach. LOMBARDY-POPLAR

N-W Himal–*Frast.*

Habit—A fast-growing, large tree, with narrow, pyramidal crown and viscid buds, up to 30 m/3.0 m. *Bark*—grey, rough, deeply furrowed on old trees. *Leaf*—ovate-rhomboid, 5–10 cm long. *Flower*—in 10 cm long catkins.

Distribution and Ecology—Cultivated in the North-West Himalayas, at 900–3700 m; also planted in avenues, especially in Kashmir. Grows on comparatively poor, dry soils.

Silvicultural Characters— Produces rootsuckers and pollards well once cut.

Cultivation/Regeneration—Rarely flowers in India and, therefore, raised from stem- or root-cuttings, and also from rootsuckers.

UTILIZATION

Reclamation—Useful for the afforestation of cold deserts and unstable slopes; suitable for growing on marl heaps of sulphur. Can be planted as shelterbelts.

Timber—Packing-cases, poles, truck and barrow-trays, coaches, furniture, cross-beams. Good-quality activated carbon is obtained from the sawdust.

Fodder—Shoot lopped.

Others—Leafbud: Yields a balsam used for cold. Yields salicine, a yellow dye and an essential oil with the smell of cammomoiles.

P. balsamifera Linn. syn. *P. candicans* Ait.; *P. tacamahaca* Mill. (BALSAM-POPLAR, BALM-OF-GILEAD, TACAMAHAC) is a tall tree, 25–30 m/2.0–2.5 m, with thick and firm leaves, small flowers in catkins and glabrous fruits, introduced from America. Suitable for afforestation of cold deserts; also, recommended for agroforestry. *P. casale* clones have been found to be suitable for the plains of northern *terai*. High alpha-cellulose can be produced from wood. *P. laciocarpa* Olivier is a tree with very large, heart-shaped leaves and small flowers in catkins, recommended for cold deserts and agroforestry. *P. suaveolens* Fisch. is a tree with medium-sized leaves; *P. tremuloides* Michx. (QUAKING ASPEN) is a very slender and straight tree, suitable for growing on coal-spoils. These have been recommended for cold deserts and agroforestry. *P. tremula* Linn. can be grown on sandy, sulphur spoils; hybrids of *P. tremula* and *P. tremuloides* can also be grown. *P. laurifolia* Ledeb. syn. *P. balsamifera* Hook. f., non. Linn. (N-W Himal–*Phalsh, pakh*) is a large, balsamiferous tree, up to 21 m, with ovate leaves, found wild and cultivated in the inner dry ranges of the North-West Himalayas, at 2400–4000 m. Suitable for afforestation of cold deserts and as shelterbelts. Recommended for agroforestry. Timber is much used as fuel. Branches are lopped for fodder. *P. robusta* Schneid, a BLACK POPLAR hybrid, introduced from France, has shown promise in the moist localities of Almora and Chakrata hills in Uttar Pradesh. Much used in Belgium and Sweden for matches. *P. yunnanensis* Dode (YUNAN-POPLAR) is a fast-growing, frost-hardy, ornamental tree, very adaptable to different soil-conditions, native of South-West China, introduced into India; its clones have shown good promise on the Almora and Chakrata hills in Uttar Pradesh; also recommended for agroforestry.

PROSOPIS Linn. (*Mimosaceae*)

Fast-growing, spiny shrubs and trees; tropical and subtropical regions, primarily being dominant in Chile, Argentina, Peru, Mexico and South-western USA; 6 spp in India; *P. cineraria* is indigenous and others have been introduced. *P. chilensis,* an American species, and its var. *glandulosa* have run wild in many parts.

The genus has very wide morphological variations and withstands the diversity of climatic and edaphic factors in India. Considered to be pests at one time, these are now considered premier for the reclamation of waste-lands, preventing erosion,and to provide energy, fodder, timber and other needs of local people. They, particularly *P. chilensis*, are of great value to arid and semi-arid regions as they withstand drought and resist salinity. They have very deep roots to reach the underground water. *Prosopis* spp are well-adapted to drifting sands and such extreme harsh conditions; they can withstand repeated grazing and cutting. Some spp fix nitrogen.

These hardy and fast-growing trees have remarkable power for coppicing.They are suitable for afforestation of arid and semi-arid lands and grow well on saline and rocky-areas. Their ability to grow in dry places is attributed to the size and density of their crown, extensive lateral rootsystem and stout, long taproots which penetrate up to 24 m or even more; the meagre requirements, rapid growth, comparative immunity to grazing and low cost of production, good-quality firewood and pods for fodder elevated these species to prominence in afforestation programmes. Some of these species can be grown on over-burdens.

P. chilensis Stuntz syn. *P. juliflora* DC. MESQUITE

Guj–*Ganda babul, pardesi babul;* Hindi–*Vilayati kikkar, vilayati babul, kabuli kikkar*.

Habit—A very variable, small to medium-sized, aggressively fast-growing tree, spiny or sometimes unarmed, semi-evergreen to evergreen, large-crowned, 20 m, with drooping, low branches., *Bark*—greyish- or dark brown, fissured, exuding gum. *Leaf*—dark green, bipinnate, with 2–4 pairs of pinnae: pinnules 10–46 pairs, 5–20 mm long each. *Flower*—small, greenish-yellow, numerous, in dense spikes. *Fruit*—yellow, straight or falcate, flat or cylindrical, often constricted between seeds, 10–30-seeded, 10–25 cm× 8–15 mm. *Seed*—ovoid, flattened, hard, yellowish-brown, shiny, 7 mm × 3 mm; April–October; 9800–36,000/ kg; germination 30–70%; needs soaking in conc. sulphuric acid for 15–60 min or hot water or scarification for quicker germination. *Flowering & Fruiting* —almost throughout the year but restricted in some areas.

The species includes several varieties and forms; two important and well-known varieties besides var. *chilensis* are: var. *velutina* Standley and var. *glandulosa* Standley. Some consider that these three varieties and *P. juliflora* DC. are independent species.

Var. *velutina* is (16 m/3.8 m) reported to be more useful for timber, whereas var. *glandulosa* with typical stout, axillary thorns is popular for afforestation, though both are suitable for arid regions. Var. *chilensis* is usually unarmed. Latter two varieties fix nitrogen.

Distribution and Ecology—Native to America, found either wild or cultivated in the dry and semi-arid areas and wastelands. Found on a variety of soils, from the coastal saline sands to arid soils, rocky terrain and sands, saline flats and sodic soils; does well in well-drained, alluvial soil in arid tracts; quickly establishes in saline depressions. It can grow in waterlogged saline soils also. In Peru, it is found growing even on sites having stagnant water. In Andhra Pradesh, it does well in murrumy tracts, laterite zones and on black cotton-soils and near watercourses.

Silvicultural Characters—Usually a small tree reaching 20 m, but under unfavourable conditions, such as very dry situations, often reduced to a shrub. Prolific seed-bearer. A strong light-demander. Hardy and drought-resistant. Freely suckers and is an aggressive invader. Coppices well.

CULTIVATION/REGENERATION

Natural Regeneration—Though slow, takes place through seed that passes through animals undigested. Readily sprouts under favourable environment; also takes place through rootsuckers.

Prosopis chilensis

P. chilensis var. glandulosa

Artificial Regeneration—Effected either through seed in March or vegetatively through root- and shoot-cuttings and stumps. For better germination of seeds, the best method is to feed the entire collected pods to goats or sheep. The excreted seed should be collected as they give higher percentage of germination. May also be treated with concentrated sulphuric acid and then washed in cold water. Seed is sown in rows 50 cm apart with a spacing of *c* 30cm between the sowings. Transplanting one-year-old, nursery-raised seedling during rainy season is preferable to direct sowing; root- and shoot-cuttings with a minimum diam of 1.25 cm at the collar and a length of 10 cm also give satisfactory results. Pre-rooted stumps from one-year-old seedlings give better results. They are planted in earthen tubes of 30 cm×10 cm which are placed in sunken beds and watered at intervals. With the first shower of rainy season, they are planted at the site. Fruiting starts at the age of 3–4 years and a ten-year-old tree may yield up to 90 kg pods annually. Can also be propagated through air-layering and the survival percentage is higher (98.6%) in comparison with seed-sowing (78.7%). It gives good biomass for gasification on waterlogged, saline soils.

UTILIZATION

Reclamation—A very fast-growing, miracle tree for dry, arid or semi-arid or waterlogged land and several other wastelands; compared with other species, it shows maximum annual growth-rate. Low-branching, bushy form in the early stages together with its excellent coppicing-power and high regenerative power make it a very highly suitable soil-binder and wind-breaker; also grown for shade and hedges. Very useful for reclaiming shallow, alluvial sand, desert-sand and shifting sand-dunes, deep sandy soils, coastal sands, degraded soils, rocky terrain, saline and sodic soils (*p*H 9.5–10.0), alkaline soils, black soils and gullies and ravines and grass-lands not affected by irrigation with saline or brackish water. Highly useful green manure and gives humus. Fixes nitrogen.

Timber—Yield of wood 75–100 t/ha. Heartwood yields tannins (5–18%). Woodpulp suitable for paper.

Fuel—Good firewood. Wood and its charcoal burn with lesser smoke and leave little ash.

Fodder—Leaves can be fed to livestock when fresh (crude protein, 26.3%) or as hay. In the villages of Gujarat, dry leaves, if eaten, are reported to have a toxic effect on the animals. Spongy walls of ripe pods are highly nutritive; a fair source of digestible protein (17%) and sugar (25%). They are important as a stockfeed. Dry pods can be incorporated into a concentrate to improve the protein in wheat- and paddy-straw; enhance the fat in milk. Seeds are not digested.

Others—Bark: Exudes a gum; used as an emulsifying agent in confectionary and mending pottery. Used as an adulterant to and substitute for gum arabic. *Leaf:* Aqueous extracts shows marked antibacterial property. Used in rheumatism and scorpion-sting. *Root:* Yields tannins (6–7%). *Flower:* Valuable source of high-grade honey. Given as medicine against miscarriage. *Fruit:* In America, it is used as staple food; flour is made into cakes and bread; used for making alcoholic beverages. *Seed:* Yields fatty oil (17.25%).

P. cineraria Druce syn. *P. spicigera* Linn.; *Mimosa cineraria* Linn.

Beng & Oriya–*Shami;* Hindi–*Khejri;* Guj–*Sami, khijado;* Kan–*Banni;* Mal–*Parampu, tambu;* Mar–*Shemeri;* Tam–*Perumbay, jambu;* Tel–*Jammichettu.*

Habit—A small to moderate-sized, almost evergreen tree, with slender branches armed with conical spines, up to 18 m/5.4 m. *Bark*—grey, rough, exfoliating in thin flakes. *Leaf*—bipinnate, usually with 2 pairs of pinnae: pinnules 7–12 pairs, oblong. *Flower*—small, yellowish, numerous, in slender spikes; December–April. *Fruit*—cylindric, torulose or flattish pod with coriaceous exocarp, 10–15-seeded; March-June. *Seed*—oblong, compressed, with moderately hard, brown testa; 25,000–27,100/kg; germination 14days, 30–70%; viable for at least 1–2 years; dispersed through wind, birds and animals.

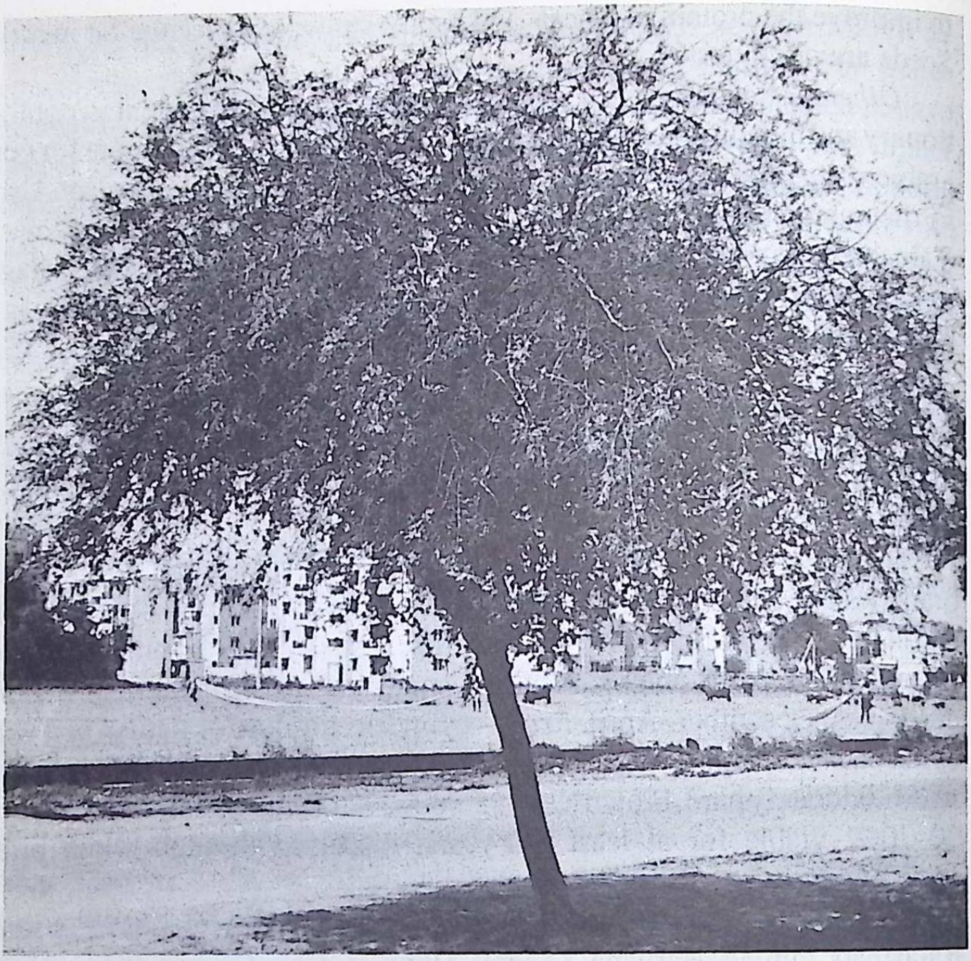
Distribution and Ecology—Plentiful in dry and arid regions in western Rajasthan, Punjab, Haryana, Gujarat, Uttar Pradesh, Central and southern India, seldom up to 800 m. Grows in dry climate, characterized by extremes in temperature. Occurs throughout the alluvial plains of Punjab and Haryana. In peninsular India, with normal rainfall, it is gregarious but scattered in open, dry forests. Found on a wide range of soils; best on deep alluvial and coarse sandy soil. Common on moderately saline soils and black cotton-soils, murrumy soils of Andhra Pradesh and can tolerate high alkalinity (*p*H up to 9.8).

Silvicultural Characters—A light-demander. Drought- and frost-resistant when old. Produces rootsuckers. Coppices well.

CULTIVATION/REGENERATION

Natural Regeneration—Through seeds in moist places, but regenerates through rootsuckers in dry situations.

Artificial Regeneration—Direct sowing in March on lands subject to occasional floods or with irrigation has been found to be successful. A



P. cineraria

spacing of *c* 2 m is initially given, thinning to 6 m in the coupe. Growth of seedlings for the first few years is slow, and up to 40–60 years is moderate. In dry areas, regeneration is effected by coppice-shoots. Transplanting is also done.

UTILIZATION

Reclamation—Suitable and recommended for areas with extremes in temperature. Recommended for controlling erosion and reclamation of sand-drift areas, gullies and ravines, stabilizing sand-dunes, alkaline (*p*H 9.8), arid and semi-arid areas, deep sandy sites, grassy blanks, waterlogged areas, alluvial, coastal sandy soils, black cotton-soils, and dry, stony soils. Recommended for shelterbelts, roadsides and agro- and social forestry. It is very well-adapted to lopping and cutting. It increases organic matter and nitrogen content in the soil; leaf useful as green manure.

Timber—Interior constructional work, toolhandles, boat-frames, agricultural implements, small turnery articles; and well-curbs. Woodash may be used as a source of potash (31.1%).

Fuel—Good firewood (sapwood, 5003 kcal/kg). Useful for making charcoal.

Fodder—Leaf (crude protein, 10.15%) and fruit given.

Others—Bark: Sweet; flour is made into cakes and eaten. Used for tanning. Exudes a gum, resembling that of mesquite. *Leaf:* Galls formed on leaves used for tanning. *Flower:* Mixed with sugar and administered to prevent miscarriage. *Fruit:* Unripe pods rich in pulp, and consumed green,dry or after boiling as food. Astringent, demulcent and pectoral. *Seed:* Kernel yields fat (7.8%).

P. alba Grisel is a tree, introduced into India from the USA for afforestation and reclamation. Grows best in arid and coastal zones, on sands with a high clay content and tolerates salt in the soil. Timber used for flooring, wine-casks, shoelasts and paving-blocks. Pods and leaves are eaten by cattle and fruits can be milled into flour for human consumption.

P. pallida H.B. & K., native to Peru, Columbia and Equador, introduced into Gujarat for afforestation and reclamation of coastal sands. Spiny and thornless forms occur. Grows on old lava flows and on coastal sands; extremely salt-tolerant and drought-resistant. Wood has high calorific value and used for making charcoal. Leaves and pods are fed to cattle.

P. stephaniana Kunth ex Spreng. is a spiny shrub or small, bushy tree, found in Punjab, Haryana and Gujarat. Pods thick, brown, sometimes with galls developing on them, found successful on coastal saline soils. Fixes nitrogen. Root and pod astringent; used in dysentery. Pod used in Iran and Afghanistan as fodder, and for tanning. Pod yields a substitute for wood-shavings, used in various industries for thermal insulation and acoustic control. Seed yields a fatty oil (2–3%).

P. tamarugo F. Phil., native to Chilean desert, is a fast-growing, long-lived tree, *c* 15 m/3.2 m, introduced into Gujarat, Rajasthan and Haryana, suitable for plantation in arid and semi-arid zones. Extremely drought-resisitant and salt-tolerant, exhibits aerial absorption of water. In Chile, it grows on the salt-lakes and deserts of northern part where no rainfall occurs, and has very low relative humidity and receives intense radiation. It can grow on ground covered with a saline crust of *c* 7 m, thick. In a short time, the trees can cover very large areas. Wood is used for furniture and makes good firewood and charcoal. Leaves and pods are eaten by sheep and goats.

PUERARIA DC. (*Fabaceae*)

Twining herbs or shrubs with tuberous roots; South-East Asia and Pacific Islands; 7spp in India.

* **P. lobata** (Willd.) Ohwi syn. *P. thunbergiana* (Sieb. & Zucc.) Benth.; *P. hirsuta* Schneid., non Kurz KUDZU

Habit—A perennial, hairy vine, with numerous, intertwining stolons which root at nodes. *Rootsystem*—long, thickened or tuberous roots, producing nodules, deep-penetrating. *Leaf*—trifoliolate: leaflets entire or shallowly 2–3-lobed, pubescent racemes, 20–50 cm long. *Fruit*—flat, oblong, linear, hairy pod, 5–10 cm long, 8–20-seeded.

Distribution and Ecology—Native to China and Japan, introduced into tropical and subtropical part of India. Able to withstand protracted drought. Grows on a variety of situations, but better adapted to moderately humid, subtropical and warm-temperate regions than to pure tropical areas.

Cultivation/Regeneration—Can be cultivated from seed and rooted nodes (crowns) or rooted vine-cuttings. In India and many other countries, it does not flower or easily set seed and propagation is through rooted cuttings. Planting is usually done during January–February, distance depending upon how quick the cover is required. Withers during the winter and survives during the summer.

UTILIZATION

Reclamation—A hardy, rapid and vigorous-growing vine, with deep-penetrating roots useful for erosion-control where most grasses and legumes do not grow. Yields forage and green manures; fixes nitrogen. Recommended for checking landslides and for conservation of soil; yields large quantities of litter and improves the fertility of soil; fixes nitrogen. Also suppresses weed-growth.

Fodder—Nutritive (crude protein, 13.1–15.9%) and palatable to all livestock and poultry; can be converted into hay. Valuable fodder as it is available during April-May when other green fodder is very scarce. Can be grown in pastures.

Others—Root: Under favourable climatic conditions may grow to a great size and attain a weight of over 35 kg; boiled and eaten as vegetable (protein, 2.1%); dried root yields sweet starch (40%) which can be used in food and medicine. *Fibre:* Stalks yield a fibre (46.2%), useful for cordage and grass-cloth.

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*A few consider that *P. trilobata* (Lour). Makino is the correct name.

P. phaseoloides Benth. syn. *P. javanica* Benth. TROPICAL KUDZU

Assam–*Jermei-kyn-saw*.

Habit—A woody, twining climber, clothed with dense, spreading, brown hairs. *Rootsystem*—tuberous, deep-penetrating, with nodules. *Leaf*—trifoliolate: leaflets entire or lobed, densely pubescent on lower surface. *Flower*—light lavender, often with whitish fringes, in long-peduncled racemes. *Fruit*—pubescent, 7–20-seeded; 5–11 cm long. *Seed*—needs scarification or treatment with conc. sulphuric acid.

Distribution and Ecology—Kumaun to Assam along the sub-Himalayan regions up to 1100 m. Also cultivated in Karnataka, Tamil Nadu, Kerala and in Uttar Pradesh. Adapts better than *P. lobata* in tropical regions. Thrives in high and extended rainfall and withstands not too severe and prolonged dry seasons and endures partial shade. Not exacting with regard to soil and grows well on heavy, clay soils and also on sandy loams. Tolerates a high waterlevel in the soil.

Cultivation/Regeneration—Propagated from seeds and cuttings. Generally cultivated with seed. Where seed-setting is poor, cuttings are planted. Seedling is better if the plant is allowed to climb and/or when there is definite dry period.

UTILIZATION

Reclamation—Ideal for erosion-control even in ravines of Uttar Pradesh. Very effective cover-crop in plantations of rubber, clove, citrus, coconut, etc. and also good green manure. Fixes nitrogren.

Fodder—Given as green feed (protein, 3.8%); relished by cattle and even poultry; rich in vitamin-C, -A and -B.

Others—Root: Eaten. *Stem:* Yields a useful strong, white fibre, suitable for twines and ropes. *Seed:* Contains protein (32.3%).

P. tuberosa DC. INDIAN KUDZU

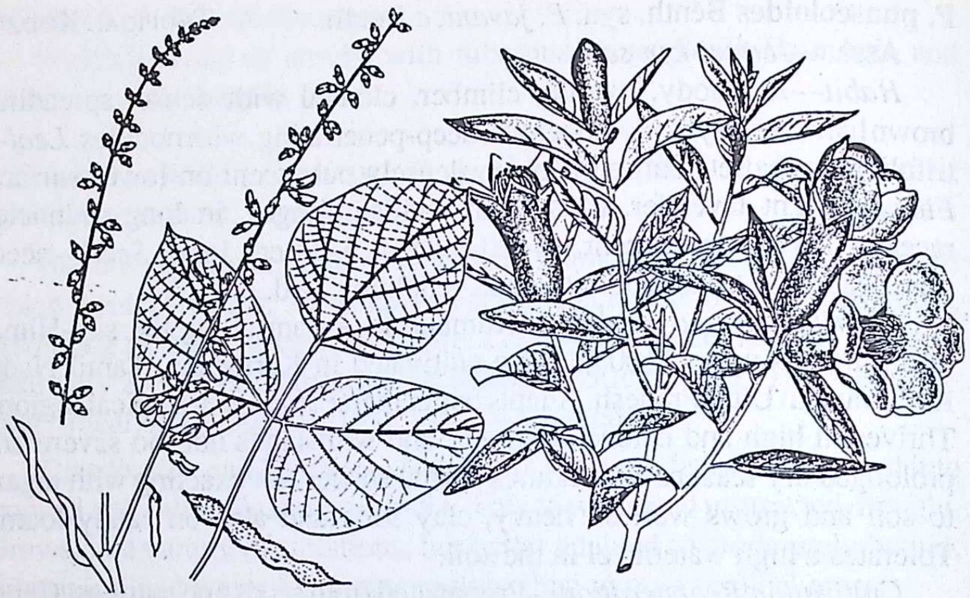
Beng–*Shinila batraji;* Guj–*Vidlarikand;* Hindi–*Bankumra, sural;* Kan–*Gumadigida;* Mar–*Ghorbel;* Tel–*Darigummadi.*

Kumaun–*Sirals;* Punjab–*Siali.*

Habit—A large, perennial climber. *Root*—very large, tuberous, 30–60 cm×25–30 cm, up to 35 kg, connected with thin roots. *Stem*—woody, 12 cm in diam. *Leaf*—trifoliolate. *Flower*—blue or purplish-blue, in 15–30 cm long racemes. *Fruit*—flat pod, densely clothed with long, silky, bristly, brown hairs, 5–7 cm long. *Seed*—3–6, produced in large numbers.

Distribution and Ecology—Throughout India, up to 1200 m. Prominent in exposed and eroded areas, covering the ground-bushes and even large trees.

Cultivation/Regeneration—Easily propagated from seeds and crowns.



Pueraria tuberosa Punica granatum

UTILIZATION

Reclamation—Suitable for reclamation and preventing soil-erosion as it has a good capacity for soil-binding, soil-covering and restoring soil-fertility.

Fodder—A nutritious, green fodder (dry, crude protein, 23.8%), given to horses and cattle; yield 7.5–10.0 t /ha. Tuber fed to horses and ponies.

Others—Bark: Yields a fibre, used as a cordage. *Leaf:* May be used as green manure. *Tuber:* Tastes like liquorice and eaten raw (crude protein, 10.9%) or boiled; 5.0–7.5 t /ha. Starch can be extracted. Demulcent, cooling and galactagogue; applied for swellings in joints. Used as aphrodisiac and tonic. Beneficial in dysmenorrhea, dysfunctional uterine bleeding and menopausal syndrome. Active against *Helminthosporium sativum*. Extract exhibits anti-implantation and hypoglycaemic activity. *Seed:* Contains crude protein (25.6%). Used in cutaneous diseases.

P. thomsonii Benth. is a climber from North Bengal, Meghalaya and Mizoram, probably useful like *P. lobata*.

PUNICA Linn.(*Punicaceae*)

Large shrubs or small trees; Socotra Islands to India; 1sp cultivated in India for fruits.

P. granatum Linn. POMEGRANATE

Beng–*Dalim;* Hindi–*Anaar;* Guj–*Dadam;* Kan & Mar–*Dalimba;* Mal–*Matalam;* Tam–*Madula;* Tel–*Daanimmachettu.*

Habit—A shrub or small tree, 5–10 m. *Bark*—smooth, dark grey. *Stem*—branchlets sometimes spinescent. *Leaf*—oblong or obovate, shining above, 2.0–8.0 cm long. *Flower*—usually scarlet-red, sometimes yellowish, 3.7–5.0 cm long and as much across, mostly solitary, sometimes 2–4 together. *Fruit*—globose, crowned with persistent calyx, rind coriaceous and woody, interior separated with membranous walls containing numerous seeds. *Seed*—angular with red, pink or whitish, fleshy sweetish sour, testa.

Distribution and Ecology—Considered native to Iran, Afghanistan and Baluchistan, found growing wild in the warm valleys and outer hills of the Himalayas at 900–1800 m; also cultivated throughout India. Subtropical tree, grows best in semi-arid climate having cool winters and hot summers; but grows under a wide range of climatic conditions, even in desert conditions, and withstands considerable frost up to 11°C. Although highly drought-resistant, it bears well only under irrigation. Though mostly cultivated and yields well on deep loamy soil, it is also gregariously common in the gravel and boulder deposits of dry ravines and similar places in the outer Himalayas, up to about 1800 m. Prefers calcareous soil containing lime-nodules and tolerates alkalinity than most other plants. Also thrives well on comparatively poor soils where other fruit-crops fail to flourish.

Cultivation/Regeneration—Generally through cuttings of hardwood for preserving the selected characters; also propagated from seeds in the peninsular region. Cuttings of 25-50 cm from one-year-old wood are planted in beds with only 1–2 buds exposed. The rooted cuttings are removed with a ball of earth around their roots and transplanted. On poor soils of Deccan, a spacing of 3.5–4.5 m is given. In lighter but deeper soils a distance of 5.5 m is suitable. Old farmyard manure and ash (20 kg/plot) are usually applied before planting; later, 3–4 baskets are applied every year before monsoon. Small quantities of ammonium sulphate, woodash and lime are also recommended. Responds well to irrigation during May–June besides monsoon; copious and regular irrigation is essential during fruiting to prevent cracking of fruit and better bearing. Normally, starts fruiting in about 4 years after transplantation. Usually harvesting is during October–December. Up to 200 fruits per tree have been recorded.

Diseases and Pests—Fruitrot may be caused, particularly in rainy season, which can be controlled by spraying Bordeaux mixture; it also reduces rot caused by *Zythia vernoniana*, dieback, dryrot, discolouration of the fruits and seed and other diseases. Grubs of the *Virachola isocrates* bore the fruit leading to considerable loss; periodical spraying of Endrin on the developing flowers checks the pest. Paperbags, plastic covers, wire-cages and tin-cases are also used to protect the developing fruits. Stem-borer causes damage in neglected orchards; petrol inserted into holes with a cotton-plug kills the insect. Cracking of fruits also causes considerable damage.

UTILIZATION

Reclamation—Can be planted to reclaim the soils mentioned above including the poor soils.

Others:—Leaf: Yields tannins (11%). *Stem & Rootbark:* Used in the treatment of tapeworms; possesses insecticidal properties. Stembark (10–25%) and rootbark (28%) yield tannins and used. *Flower:* Styptic to gums; useful in biliousness, eye-sores, ulcers, vomiting, sore throat and hydrocele. Buds beneficial in giardiasis, internal as well as external bleeding. Extract of flower, rind and leaf is antibacterial against *Vibrio cholerae*. Bud yields a red dye used for dyeing cloth. *Fruit:* Largely used as a dessert (protein, 1.6%). Yields a delicious juice which also blends well with other juices; a beverage, an excellent syrup and a wine are prepared. Contains important vitamins and minerals. All parts possess antibiotic activity and antifungal activity, particularly the extracts from fruit. In Unani medicine, fruit considered tonic for heart and liver, demulcent, digestive and stomachic, and cooling. Sweet types good in inflammation of stomach and in heartpain. *Seed:* Dried and widely used as condiment. *Rind:* Yields tannins (up to 26%); used for tanning. Given in diarrhoea and dysentery. A source of a dye which gives yellowish-brown to khaki shades; used for dyeing wool and silk.

RHIZOPHORA Linn. (*Rhizophoraceae*)

Evergreen trees and shrubs, known as MANGROVES; tropics and subtropics; 2 spp in India.

R. mucronata Lam. TRUE MANGROVE

Beng–*Kamo;* Kan–*Kandaale;* Mal–*Panicchakandal;* Mar & Tam–*Kandal;* Oriya–*Rai;* Tel–*Uppuponna.*

Andamans–*Bairada.*

Habit—An evergreen tree, sometimes up to 27 m/2.2 m, with aerial and stilt-roots as well as pneumatophores. *Bark*—very roughly reddish to black, with horizontal fissures encircling the stem, non fibrous, easily broken into small pieces. *Leaf*—broadly elliptic-oblong, coriaceous, 7–20 cm × 3–13 cm. *Flower*—white or yellow, in 2–10-flowered cymes. *Fruit*—conical-ovoid,

Rhizophora mucronata

4–5 cm long, dull brown-green, hypocotyle in old fruits protruding from the fruit, buoyant.

Distribution and Ecology—Throughout the tidal shores and creeks and in the Andaman and Nicobar Islands. Commonly found on the outer fringes of the mangrove-swamps where the water is decidedly salty and the action of the tides and waves is most strongly felt.

Silvicultural Characters—A strong light-demander. Highly tolerant to saline waters. Gregarious or sometimes found mixed with other vegetation and forms impenetrable belt of many kilometres as much deep as 1.6 km.

CULTIVATION/REGENERATION

Natural Regeneration—Freely occurs from the viviparous seeds. On falling from tree, the seedling establishes itself in shallow water. Seedling is buoyant and sometimes carried away and survives till it establishes. These can also be collected and transplanted.

UTILIZATION

Reclamation—Very useful for soil-conservation and afforestation along the shores and estuarine coasts. Forms dense thickets and forests along estuaries, salt-marshes, shallow brackish streams and lagoons, and mudflats. Can easily be transplanted for reclamation and for fuel.

Timber—Heavy construction, piles for bridges, tool-handles, mallet-heads, reinforcing mudwalls, and frames of houses in and around swamps. Thin split-stems are made into baskets. Yields tannins; used in industry.

Fuel—A good firewood (4888 kcal/kg); moisture-removed, exhausted wood used as fuel in boilers. Suitable for making charcoal.

Fodder—Shoot and fruit used as fodder.

Others—Bark: A powerful astringent. Yields tannins (25.35%), commonly used in leather industry along with wood-tans; used in drilling-muds, preservation of fishing-nets, softening water in boilers and for resins and adhesives. *Spent-bark:* Forms a source of furfural; ash may be used as fertilizer because of lime and calcium. *Shoot:* Young ones cooked and eaten. *Leaf:* Yields tannins (9.1%). *Fruit:* Sweet, eaten; juice made into a light wine; raw fruit yields tannins (12%).

R. apiculata Blume syn. *R. candelaria* DC.; *R. conjugata* Hanslow, non Linn. (Mal–*Nayakandal*) is a small, evergreen tree, up to 7.6 m, with elliptic-lanceolate leaves and white or yellowish flowers, found in the tidal marshes of India and the Andaman and Nicobar Islands. Recommended for the afforestation of swampy areas and estuarine coastland. Bark yields tannins (25–36%), used for processing hides and skins. Spent-bark and wood are used as those of *R. mucronata.*

RICINUS Linn. (*Euphorbiaceae*)

Large shrubs or small trees; tropics and warm regions; 1sp in India; cultivated for its seeds, which yield Castor-oil.

R. communis Linn. THE CASTOR

Beng–*Bheranda;* Guj–*Diveligo;* Hindi & Mar–*Erandi;* Kan–*Haralu;* Mal–*Avanakku;* Tam–*Amanakku;* Tel–*Aamudamuchettu.*

Habit—An annual or perennial bush or occasionally a soft-wooded, small tree, up to 6 m or more. *Leaf*—green or reddish, 30–60 cm in diam, palmately 5–11-lobed, serrate, long-petioled, with conspicuous glands. *Flower*—monoecious: staminate on the lower part and pistillate on the upper part of 30–60 cm long peduncle. *Fruit*—a capsule, covered with soft, spine-like processes. *Seed*—oblong, smooth, variously coloured, mottled, varying in size; soaked for 12 hrs for better germination.

Distribution and Ecology—Native to tropical Africa, found throughout India, mostly under cultivation as an oil-crop, essentially in the tropics, up to 2000 m; also found as an escape; occurs in scrubby jungles of the outer Himalayas and cultivated in many states, particularly in Andhra Pradesh, Karnataka and Gujarat. Found in semi-arid, dry regions and on sandy or clayey, deep, black cotton-soils; red loams, murrumy soils and on good light, alluvial loams; grows even on gravelly and poor soils and can withstand dry, arid climates, heavy rains and floods, but frost-tender. Also, it is grown under irrigation and as a shade- or border-crop to ginger, turmeric, sugarcane, etc.

CULTIVATION/REGENERATION

Natural Regeneration—Freely regenerates under favourable conditions.

Artificial regeneration—As a crop, it is grown as main-season crop. Generally, the seed is sown during June–July or sometimes during September–October in lines 1–2 m apart, depending upon the type of crop. In Andhra Pradesh, 50 cm spacing in the rows and 90 cm between the rows is recommended; seed-rate also varies from 4 to 15 kg/ha. Application of farmyard manure and fertilizers generally benefit the crop. Annual crops are harvested within 4–9 months and perennials continue to bear 10–15 years. Several diseases and pests have been recorded.

Ricinis communis — windbreak

UTILIZATION

Reclamation—Recommended to grow on soils mentioned above, particularly in dry regions to reclaim wastelands. In Morocco, it is grown for fixing sand-dunes. Recommended for agroforestry and to grow as shelterbelts in controlling sand-drift areas, and as shade-bearer for coffee and tea; also to reclaim and stabilize the sides of railway-lines, road and fringes of forests. In Rajasthan desert and Central regions, it is used as shelterbelts, windbreaks and hedge to control sand-shifting.

Fuel—Dried stems and hulls are highly combustible fuels.

Fodder—In Assam, leaves are fed to *eri*-silkworm. Occasionally fed to cattle also (crude protein, 24.4%).

Others—*Leaf:* Used for poulticing or fomenting sores, boils and swellings, emetic in poisoning by narcotics like opium, and in jaundice. Possesses insect-repellant property. *Stem:* Suitable for strawboard and paper. *Seed:* Aqueous extract used for clarifying jaggery. Yields castor-oil (37-61%); commonly given as a purgative for humans and animals; also in diarrhoea, in dentifrices, skin-diseases, rheumatism and sciatica. Used as an illuminant and as preservative of grains. Utilized in paints, enamels and varnishes, oiled fabrics, linoleum, Turkey red oil, inks, hydraulic brakes, greases, polishes, cosmetics, soap-making, pharmaceutical foams, plasticizers, insecticidal formulations, in tanneries for preserving leather and in textile industry. Substituted for tung-oil. Castor-wax is produced on hydrogenation and used as a substitute for carnauba-wax. Contains ricin which is a highly toxic component to human beings and animals; possesses antitumor properties. *Cake:* Commonly used as manure. Detoxified seed-cake is edible (protein, 39.8%). Used as a source for sodium glutamate, synthetic fibre, distempers, oilbound waterpaints, adhesive compositions and moulded products.

ROBINIA Linn. (*Fabaceae*)

Deciduous trees and shrubs; North and Central America; 1sp in India.

R. pseudoacacia Linn. BLACK-LOCUST, FALSE ACACIA, ROBINIA

Kashmir–*Kikar*.

Habit—A fast-growing, handsome, medium-sized thorny, deciduous tree, up to 30 m/2.8 m. *Bark*— thick, rough, brown, longitudinally furrowed. *Leaf*—imparipinnate: leaflets 7–23, up to 5 cm long, elliptic or oval. *Flower*—white, very fragrant, in axillary, pendulous racemes; March–May. *Fruit*—flat, brown pod, 12.5 cm × 1.8 cm; September–October. *Seed*—up to 16 in a pod, 5 mm long, reniform, dark brown; 30,000–80,000/kg;

December–January; germination 8–30 days, 70–100%; viable for 3–4 years in cold, dry places; needs cold-water soaking for 24–36 hrs or immersion in hot water for 12 hrs, or scarified and immersed in sulphuric acid.

Distribution and Ecology—Native to North America, introduced into the hills of Himachal Pradesh in 1890 and later in Jammu and Kashmir for ornament, *c* 60 years ago, and well-established in North-West Himalayas, and now assumed importance in reclamation and afforestation. Grows well on a variety of geological formations from the plains up to 3000 m, the optimum range probably being 1500–2000 m in the Himalayas. Recently introduced on the dry Deccan hills with much promise; also reported to be growing in Uttar Pradesh. Does not tolerate waterlogging and avoids stiff heavy soils and shallow rocky ground. Well-drained, deep, gravelly soils with adequate moisture and new landslips or alluvial flats are most suitable. On shallow soils, it remains bushy and stunted owing to repeated dieback.

Silvicultural Characters—A strong light-demander. Does best in a temperate climate, though performs well in subtropical hills which are not too dry. Thrives in areas with –11° to +35°C and can tolerate higher temperatures with a rainfall of 700–2000 mm. Seedlings and young plants may suffer prolonged drought or early or late frost; but, mature plants are drought- and frost-hardy. Freely produces rootsuckers. Coppices well. Normally windfirm but liable to be knocked down on exposed spurs; also liable to suffer from snow-breaks.

CULTIVATION/REGENERATION

Natural Regeneration—Readily and profusely reproduces through rootsuckers, forming thickets on the hillsides; growth prolific and fast.

Artificial Regeneration—Through seed or root-cuttings, but does not come up well by direct sowing of seeds; nursery-seedlings transplant well. In areas which hardly receive monsoon, May–June is the best period for sowing the seeds in sunken beds to retain moisture. In the monsoonal region, the sowing is done on raised beds during mid September–mid March, depending upon the altitude. One-year-old seedlings (0.6–1.2 m) are pricked at 22.5 cm×22.5 cm and replanted after 6–12 months at 2.4 m×2.4 m in pits or trenches; but, on hot and exposed sites, a closer spacing or 1.8 m×1.2 m in contour-trenches is recommended. Sowing and transplanting are avoided during rains. Weeding and cleaning are necessary in early stages.

UTILIZATION

Reclamation—A very valuable, nitrogen-fixing tree for reclamation, conservation of soil and anti-erosion measures, particularly for highly acidic soils; a salt-tolerant species, suitable for afforestation and rebuilding of eroded granite and sandy calcareous land, industrial wastelands, coal-mine regions and severely eroded copper-basin; also suitable for growing on mine-spoils of manganese, sandy sulphur, magnesium, iron, zinc and lead, banks left after fire-clay and on the slopes for soil-improvement. Also suitable for reclaiming cold deserts. Fixes nitrogen. Planted on roadsides and as shelterbelts; recommended for agro- and social forestry. A multi-purpose tree for the middle hills and for improving degraded sites. Becoming popular for farm- and home-stead plantings in the Himalayan foot-hills, alongside of *Grewia optiva* and *Celtis australis*, for its fast growth and abundant production of palatable fodder. Now common on field-margins with little or no apparent effect on the crops.

Timber—Poles, posts, sleepers, wheels and spokes, agricultural implements, tool-handles, shoelasts, sportsgoods, pins for insulators, cart- and ship-building, furniture, and turnery, and suitable for paper. Burrs provide attractive tabletops. Heartwood yields a dye, robinetin, yielding different shades with different mordants and tannins (3%).

Fuel — Commonly used as firewood.

Fodder—Leaf (crude protein, 20–25%) and shoot are excellent supplementary fodder for cattle in the hilly regions, but reported to be toxic when young. Seed suitable for cattle-feed.

Others—Bark: Yields tannins (6%). *Leaf:* Antispasmodic and laxative. *Flower:* Yields a volatile oil with peach-like odour; used for flavouring and seasoning, and in aromatic waters and sherbets. *Seed:* Eaten after cooking (crude protein, 38.8–39.5%). Yields a drying oil (10–15%).

Bark, leaves and roots are reported to be toxic.

* SACCHARUM Linn. (*Poaceae*)

Perennial grasses; tropics and sub-tropics; 10 spp in India.

S. bengalense Retz. syn. *S. arundinaceum* Hook.f. (Fl Br Ind) in part, non Retz.; *S. munja* Roxb.; *S. sara* Roxb.; *S. ciliare* Anders.; *Erianthus sara* Rümke; *E. ciliaris* Jesw.= *Erianthus munja* Jesw.

Hindi–*Munj, sarakanda.*

Habit —A tall, erect, caespitose, perennial grass, growing in clumps, up to 6m. *Culm*—biennial, pale, solid, pithy, smooth, with an inconspicuous growth-ring and root-zone. *Leaf*—glaucous-green, rough on margins with dense hairs, close to the ligule, 1–2 m × 3 cm; leafsheath glabrous, smooth,

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* Includes *Erianthus* Michx.

100–200 cm long. *Spikelet*—in pairs, one sessile and other pedicelled, awnless, in recemes, 30–90 cm long, pale cream to dark reddish-purple.

Distribution and Ecology —Mainly in Punjab, Uttar Pradesh, Bihar, West Bengal and Orissa. Grows well on alluvial sandy banks of streams not subject to waterlogging; includes a large number of forms varying in habit, nature of inflorescence and adaptability to various conditions of soil; some of them grow in very dry situations.

UTILIZATION

Reclamation—Recommended for afforestation of marshy wastelands and to grow as shelterbets in controlling sand-drift areas, and sand-dunes, gullies and ravines.

Fodder—Young leaves valued as fodder. Ripe grass (crude protein, 6.18%) along with molasses or other seeds can be fed to cattle during scarcity. Dry grass unpalatable, but alkali-treated grass is more palatable; young grass can be converted into hay (crude protein, 61%) and can be fed along with a palatable fodder like *berseem* or wheat-bran, etc.

Others—Plant: Can be substituted for paddy-straw, wheat-straw and rags in strawboards; yields rayon-grade pulp (yield, 33.4–36.5%); a good source of furfural (yield, 5.67%, dry basis). Can be tried as a source of alcohol. *Reed:* Yields reducing-sugar (19.5%); may be used for producing alcohol. *Root:* May be used in kidney disorders.

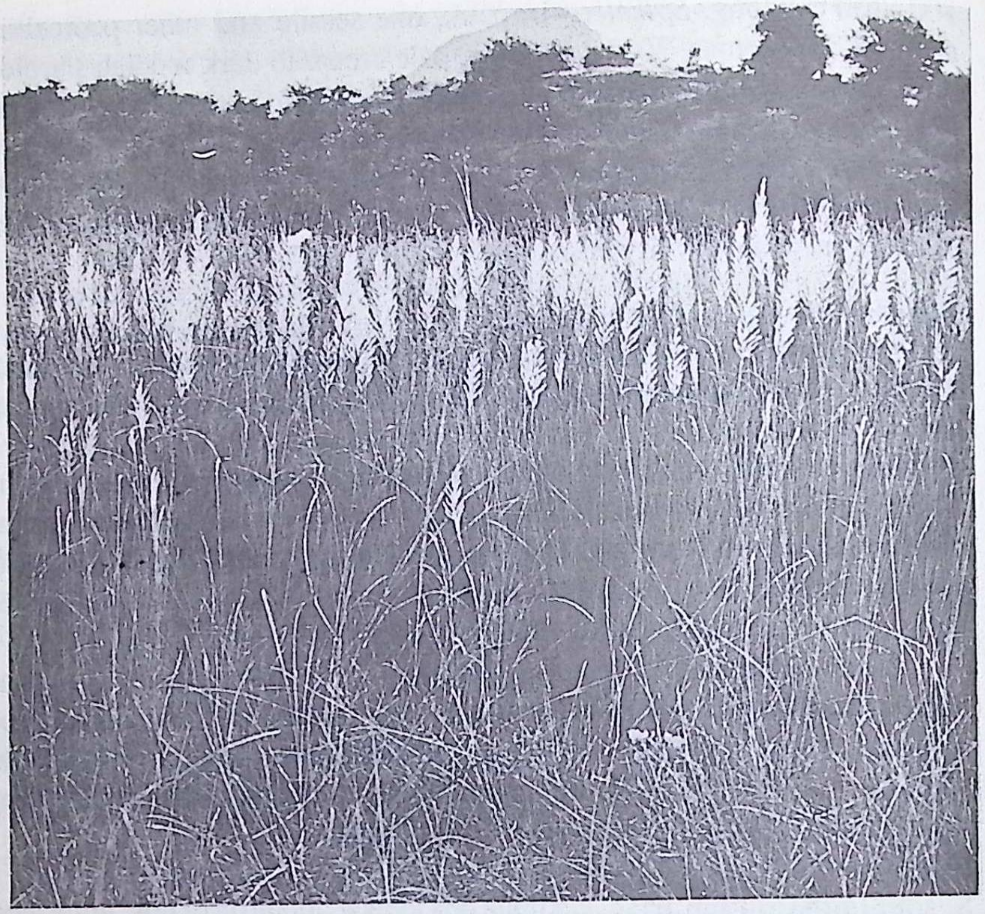
S. spontaneum Linn.

Hindi–*Kans, kas;* Sans–*Kasa.*

Habit—A perennial grass, growing in stools or forming cane-breaks, with most often aggresive rhizomatous tillering, 3 m. *Culm*—slender green-grey, ivory or white, hard but very pithy, often hollow in centre, varying in diam from 5 to 10 mm; internodes usually long and nodes always thicker than internodes, rooting at node. *Leaf*—a long, linear, narrow, sometimes reduced to the midrib. *Inflorescence*—panicle varying in length and colour from pale or greyish-white to purple-grey. *Spikelet*—in pairs, pedicelled spikelet of the pair always blooming first, glumes 4, lodicules ciliate. *Flowering & Fruiting* —towards the end of rains.

Gained importance as a valuable material for breeding to yield a hybrid 'Co 203', resistant to adverse climatic conditions. A local clone of Java and 'Co 203' have extensively been used to produce commercial canes.

Distribution and Ecology—Very widely distributed from the slopes of the Himalayas from 1800 m, in North India to the equatorial regions. Forms of this polymorphic species are not easily distinguishable among themselves but differ in habit and morphological characters, ecological adapta-



Saccharum spontaneum

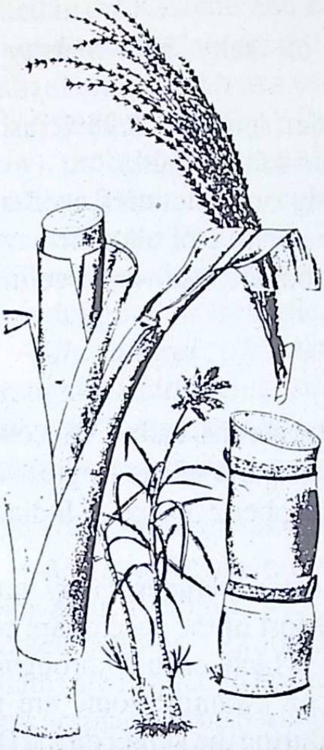
tion to soil, climate, etc. The Indian forms show, in general, a tufted habit, with sugar varying from 0.5% to 17% in juice.

UTILIZATION

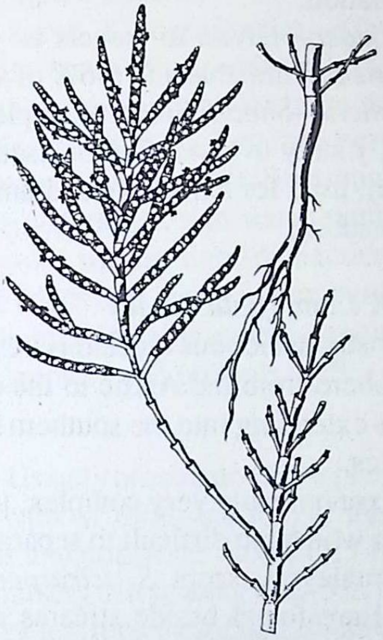
Reclamation—Recommended for cultivation as shelterbelts in controlling sand-drift areas and for reclamation of mined and other wastelands. Becomes a very pernicious weed, if allowed, holding the soil together.

Fodder—Grass normally not relished by cattle except during scarcity (crude protein: preflowering, 5.30%; ripe, 3.35%); favourably comparable with paddy- or wheat-straw or guinea- or Napier-grass; dried ones used as hay.

Others—Plant: Reported to possess insecticidal properties. In Ayurveda, used as laxative, sexual stimulant, in burning sensations, phthisis, vesical calculi, blood-diseases, constipation and excess of bile. *Shoot:*



S. officinarum



Salicornia brachiata

Eaten in times of scarcity. *Culm:* Suitable for pulp for different types of paper; also suited for hard-boards, rayon-grade pulp and activated carbon. Used for thatching. May be used for producing gasohol. *Leaf:* Employed for cordage and broom. Also used for thatching. *Pollen:* Sometimes causes allergy.

S. officinarum Linn. is suitable for waterlogged areas.

SALICORNIA Linn. (*Chenopodiaceae*)

Annual or perennial, leafless, fleshy herbs or shrubs; native to salt-marshes of Asia, Africa, Europe and North America; 1 sp in India.

S. brachiata Roxb.

Guj–*Muchul;* Mal & Tam–*Umari-keerai;* Tel–*Koyalu.*

Habit—A much-branched, herbaceous perennial, with jointed stems, 30–45 cm. *Branches*—rather slender, joints 6–12 mm long. *Flower*—sunk in cavities of the joints, 3 on each side. *Fruit*—membranous.

Distribution and Ecology—West Bengal to Gujarat. A halophyte of salt-marshes along the seacoast.

UTILIZATION

Reclamation—Suitable to grow on salty and marshy soils for reclamation.

Fodder—Given to camels as fodder (protein, 6.98%; ash, 8.97%); contains sodium chloride (86% of water-soluble salts).

Others—Shoot: Eaten after pickling or sometimes used as potherb. Strongly salty in taste. Can be used as a source of alkaline earth (*sajji* or *barilla*); used for extracting sodium carbonate; ash was used in soap- and glass-making.

SALIX Linn. (*Salicaceae*)

Mostly deciduous dioecious trees and shrubs, called WILLOW; northern hemisphere from the Arctic to the cooler parts of the tropics, with a few species extending into the southern hemisphere; 35 spp in India, including 4 exotics.

Taxonomically very complex, the genus includes, many varieties and hybrids which are difficult to separate. Most of the species are confined to the Himalayas except *S. tetrasperma* which occurs throughout India. Several are found beside streams and on swamps; some are grown for ornament, and a few for timber. Leafless during the winter on the Himalayas, they sprout early during the spring. Seeds are minute with long, silky,hairs helping in dispersal. Natural seedlings readily spring up in quantity on freshly exposed ground, on landslips, in cuttings, in depressions, and similar places, and help in fixing unstable hillsides and are pioneers in reclamation. Some can be planted for stabilizing iron-mine tailing and on slate-waste. Several species are grown on large scale for fuel, fodder and timber. Many species contain tannins and salicin in most of the parts, besides other chemicals. Tannins are employed in skin-processing. Salicin is slightly bitter, antirheumatic and antiperiodic; also given in cough.

S. alba Linn. EUROPEAN WILLOW, WHITE WILLOW

Kashmir–*Butvir, vivir;* Himachal Pradesh & Punjab–*Bisbhushan, madnu, malchang.*

Habit—A large, fast-growing, deciduous tree, with olive-green, yellow or purple branches, 20–25 m/60 cm. *Bark*—reddish-green or brown, cracking with age. *Leaf*—narrowly lanceolate, ash-grey, silky. *Flower*—male and female in separate catkins. *Fruit*—ovoid-conic capsule. *Seed*—yellow, ovoid, keeled.

Distribution and Ecology—Native to Europe, introduced into India, widely cultivated in the western Himalayas, up to 2400 m; mostly cultivated in the Kashmir and Kulu valleys along river-stream, canal-banks and around lakes. Also, reported to have been raised in dry temperate zones of Lahaul and Ladakh at a much higher altitude.

Ssp.*coerulea* (Sm.) Rich. f. syn. *S. coerulea* Sm. (CRICKETBAT WILLOW), probably native to Britain, up to 30 m, with upright branching and shallow-fissured bark, cultivated in cool climate on large scale in Kashmir and Himachal Pradesh but at lesser altitude. Requires perpetually moist, well-aerated, deep, fertile, loamy soil, never subject to drought or prolonged waterlogging, though tolerates waterlogging to some extent.

Silvicultural Characters—A strong light-demander. Sensitive to drought, waterlogging, strong winds and heavy snow, but frost-hardy and tolerates temperatures well below freezing-point; becomes bushy and stunted near stagnant water. Coppices and pollards well.

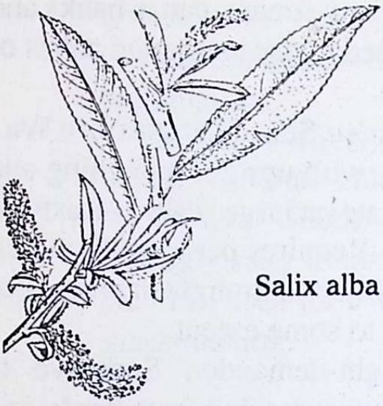
CULTIVATION/REGENERATION

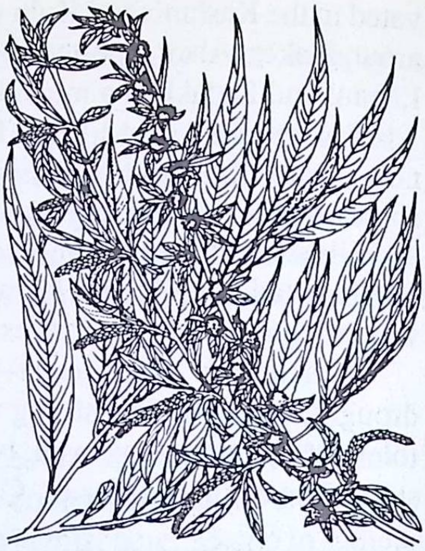
Artificial Regeneration—Usually propagated from planting sets, called *mawas* in Kashmir, with or without roots and longer than cuttings, and rooted cuttings. Uprooted sets and pollarded shoots (3.5 m long × 2–3 cm diam) are planted in holes in nursery at a spacing of 2–5 m asunder. Rooted sets are planted out in winter. Leafless rooted cuttings (20–25 cm long×1–2 cm diam) are planted in nursery at 60 cm × 30 cm, leaving one bud above the ground. When 2.5–3.0 m long, they are transplanted during winter. A few diseases and pests have been recorded. Ssp. *coerulea* can be propagated through mature, healthy cuttings (90–120 cm/2.5–5.0 cm); planted in nursery at 90 cm × 120 cm with 60–90 cm of cuttings burried; smaller cuttings having 1 or 2 buds are fully burried. In the second year, the sets reach *c* 3 m and 7–10 cm girth. These are transplanted on a moist, fertile, well-drained and manured, deep, rich, loamy soils with irrigation for good growth during November–March. A spacing of 9 m on canal-banks and in rows and in plantation 10 m and 12 m are given. They take 4–6 years; pollarding ensures thick and straight stems. Quality of wood depends upon site.

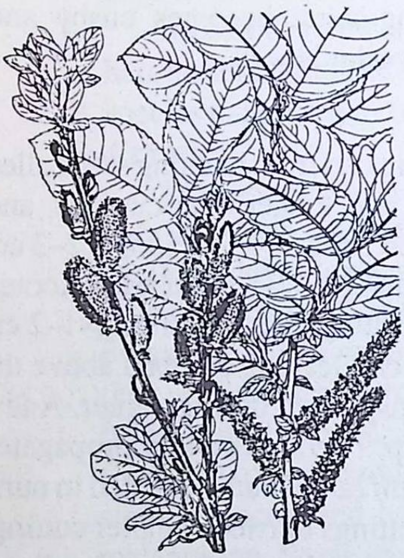
UTILIZATION

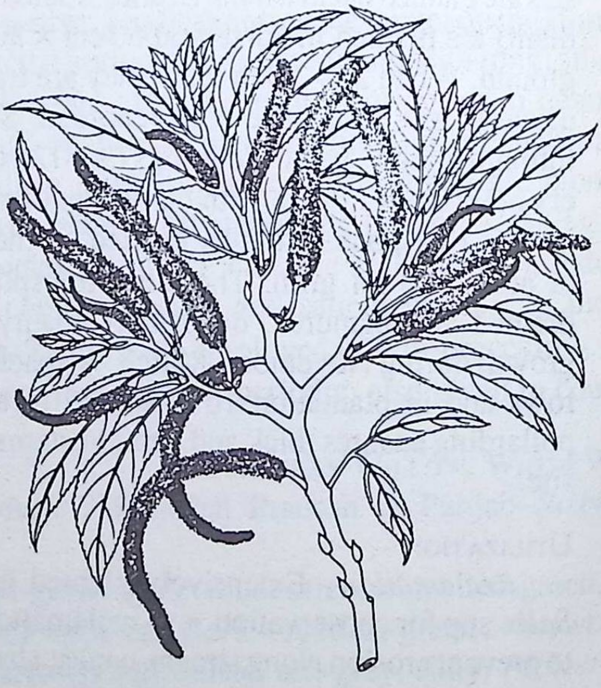
Reclamation—Extensively planted in cold deserts along with other *Salix* spp for conservation and reclamation of soil in catchment areas, and to prevent erosion along stream-banks; also planted as live-fence for check-dams, on roadside, in avenues and for recreation and agroforestry.

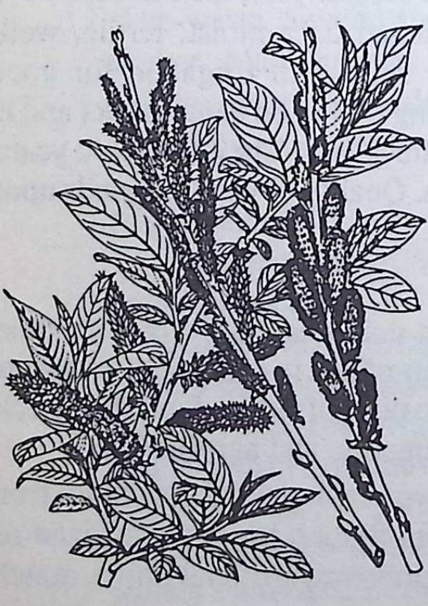
Timber—Trees from swampy areas give heavier wood than those from bunds and the latter provides sports-quality timber; primarily utilized for cricket bats and poloballs; also used for fruitboxes, artificial limbs, match-


Salix alba


S. babylonica


S. caprea


S. tetrasperma


S. wallichiana

wood, honeycomb frames, toolhandles, fibreboards, fenceposts, agricultural implements, boats, etc. Suitable for paper. Timber from ssp. *coerulea* has straight grain and withstands compression and is the best for cricket-bats, though also used for boxes, basket-veneers and match-splints.

Fuel—Good firewood; also used for making charcoal, though low in calorific value.

Fodder—Tender twig lopped. Contains maximum protein at the beginning of vegetative growth.

Others—Bark: Dried inner bark powdered and made into a bread. Astringent. Yields tannins (5–7%) and salicin; utilized as haemoptysis, in rheumatism, diarrhoea and dysentery. *Twig:* Tender ones are consumed; also pliated into baskets and ropes. Decoction is given as a beverage; also employed as an adulterant to tea.

S. babylonica Linn. WEEPING-WILLOW

Tel–*Attuppalai*.

Garhwal–*Gadhbains;* Kashmir–*Biasa, guir;* Nepal–*Bhosi;* Punjab–*Bisa*.

Habit—A small to moderate-sized, fast-growing, short-lived, ornamental tree. *Leaf*—linear-lanceolate; young leaves aromatic like roses. *Flower*—in short, terminal catkins on leafy peduncles. *Fruit*—narrowly conic, glabrous capsule.

Distribution and Ecology—Probably native to Central and southern China, occurs along the riverbanks and watercourses in India; also planted in the North up to 2700 m. Thrives well on clayey soils in swampy places along the riverbanks and streams, preferring low elevations and warm climate, male trees being more common.

UTILIZATION

Reclamation—Since the plant has a fast rate of growth, it can be used in agro- and social forestry, particularly in waterlogged areas. Can withstand heavy lopping.

Timber—Sportsgoods, brake-blocks, gate-fixtures, buildings, and fences. Good-quality activated charcoal can be obtained from sawdust.

Fodder—Provides excellent green feed (crude protein, 7.5%) for livestock during the summer and favourably compares with lucerne.

Others—Bark: Yields tannins (3.9%). Astringent.

Leaf—Astringent; infusion given in rheumatism. Yields tannins (4.9%) and salicin (3–4%). Extract of aerial parts exhibits antifertility properties. *Catkin*: Antipyretic.

S. caprea Linn. THE SALLOW, GOAT-WILLOW

Hindi & Punjab–*Bedmushk.*

Habit—A large shrub or a small tree, up to 10 m/1.2 m. *Bark*—dark grey or yellowish-brown. *Leaf*—variable, broadly ovate to oblong-orbicular. *Flower*—in catkins, male catkins sweet-scented.

Distribution and Ecology—Planted for ornament in Kashmir, Punjab, Himachal Pradesh and Uttar Pradesh. Less exacting than most willows as to soil, growing on dry and even rocky ground and also in swampy localities.

Cultivation/Regeneration —Can easily be raised from cuttings.

UTILIZATION

Reclamation—Useful as a soil-binder; also planted for hedges and can be grown on mined sites as undergrowth to *Betula* spp.

Timber—Useful in haemoptysis.

Fuel —A good source of gunpowder charcoal.

Others—*Bark:* Astringent. Yields tannins (8–13%) and salicin. *Leaf:* Yields an oil used in making perfumed waters and as tonic; decoction febrifugal; used as astringent in piles. *Flower:* Yields an essential oil.

S. fragilis Linn. CRACK- OR KASHMIR-WILLOW

Himachal Pradesh–*Tilchang.*

Habit —A tree, up to 30 m/6 m. *Bark*—grey, deeply fissured, not peeling. *Leaf*— lanceolate, 6–15 cm long, silky when young. *Flower*—in catkins, on leafy peduncles. *Fruit*—narrowly conic, 6.1 mm capsule.

Distribution and Ecology—Commonly cultivated on swampy grounds in Kashmir and Himachal Pradesh, at 1350–3300 m; also planted in Punjab and Haryana. Prefers a deep well-drained soil along the streams, avoiding clayey and gravelly soils. Reclaimed swamps, rich in alluvium and subject to flooding are very suitable, but cannot withstand waterlogging.

Cultivation/Regeneration—Sets are planted during March–April, at 4–5 m × 6.0 m. Protection from cattle, sheep and goats is necessary. Lopping of the tree is done once in three years.

UTILIZATION

Reclamation—Commonly cultivated for fuel in plantations on swampy grounds, recommended for reclamation of cold deserts.

Timber —Suitable for cricket-bats; also employed in match industry.

Fuel —Used as firewood, and for charcoal to be used in gunpowder.

Others —*Twig:* Woven into baskets. *Bark:* Yields tannins (6–12%) and salicin (0.23%). *Leaf:* Yields tannins, a dye and salicin.

S. tetrasperma Roxb. INDIAN WILLOW

Beng–*Panijama;* Hindi–*Bod, jalmala;* Kan–*Niravanji;* Mal & Tam–*Vanji;* Mar–*Wallunj;* Oriya–*Baisi;* Tel–*Eetipaala.*

Assam–*Veh;* Kashmir–*Vir, bin;* Garo–*Bol-slak;* Khasi–*Jamyneri;* Madhya Pradesh–*Dhanie;* Punjab–*Bis, bain;* TRADE–*Indian Willow.*

Habit—A small to moderate-sized, fast-growing, deciduous tree, with silky-pubescent shoots, sometimes up to 24 m/3 m. *Bark*—greyish-brown or blackish with rough, vertical fissures. *Flower* —in lax-flowered male and female catkins, more or less pendulous. *Fruit* —glabrous, 4–6-seeded capsule, 7mm long. *Seed*—grey-blackish-brown.

Two types of plants are distinguished: one that grows on the highland, called the *Nag-veh*; and the other on the wetland called *Pani-veh.*

Distribution and Ecology—Gregarious along the banks of rivers and streams and in wet, swampy waterlogged places throughout the greater part of India, up to 1800 m on the Himalayas and 2100 m on the Nilgiri hills. Withstands flooding, often sending out small rootlets near the base of the stem when inundated.

Cultivation/Regeneration—Grows well from cuttings planted in moist places. Frost-hardy. Coppices and pollards well.

UTILIZATION

Reclamation—Recommended for reclaiming wet, swampy soils, waterlogged soils, gullies and ravines and mined wastelands, and for social forestry.

Timber—Posts, planks. house-building, furniture, agricultural implements, and match-boxes. May be useful for pencils, pen-holders, brush-backs, packing-cases and cricket-stumps.

Fuel —A good firewood; yields charcoal for gunpowder.

Fodder—Shoot lopped.

Others—Bark: Yields tannins (6.5%). Extract possesses antifertility properties. *Leaf:* Possesses medicinal properties.

S. daphnoides Vill. (VIOLET WILLOW; Himachal Pradesh–*Richang;* Jaunsar–*Bashroi;* Kashmir–*Yur;* Punjab–*Bedi*) is a large shrub or tree, with oblong-lanceolate leaves, silky catkins and glabrous capsules, found on the Himalayas from Kumaun westwards, at 750–4500 m, extending into the inner arid zone. Recommended for reclamation of cold deserts. Timber is used as fuel, and for agricultural implements, utensils, tubs, tools and buildings. Young shoots and catkins and inner bark are eaten.

S. elegans Wall ex. Anderss. (Punjab–*Bitsu, bida;* Jaunsar–*Chhoti karvi*) is a shrub or a small tree, with elliptic-obovate or oblong leaves, gregariously found on the Himalayas from Kashmir to Nepal, at 1800–3600 m. A very useful plant for afforestation. Wood used as fuel. Shoots lopped for fodder.

S. flabellaris Anderss. is a procumbent shrub, with angled branches, obovate or broadly ovate, long-petioled leaves and glabrous, red capsule, found on the western Himalayas from Kashmir to Kumaun, at 3300–4500 m, and in Sikkim. Suitable for cold deserts.

S. hastata Linn. is a small shrub, 2.1 m, with silky-hairy shoots, oblong to lanceolate leaves, found on the western Himalayas, from Garhwal westwards, at 2700–4500 m; also found in Sikkim, at 3450 m. Recommended for reclaiming cold deserts.

S. wallichiana Anderss. (Kashmir–*Jangli-bains;* Punjab–*Bivir;* Jaunsar–*Bhaishara*) is a very variable shrub or small tree, found wild and cultivated on the Himalayas, up to 3750 m. Recommended for reclaiming cold deserts. Bark contains tannins (9.6%). Twig used for making baskets and fences. Leaf lopped for fodder.

SALSOLA Linn. (*Chenopodiaceae*)

Weedy, herbaceous plants; mostly on seashores and on saline soils in temperate regions; 5 spp in India.

S. baryosma Dandy syn. *S. foetida* Delile ex Spreng. SALTWORT

Tel–*Ellakoora.*

Punjab–*Goralane, shora;* Rajasthan–*Lani.*

Habit—A stout-hoary, pale, excessively branched shrub, 0.9–1.2 m. *Leaf*—minute, subglobose or broad ovate, fleshy. *Flower*—minute, silvery white, in short, cylindric spikes.

Distribution and Ecology —Plains of Punjab, the Upper Gangetic region, North Gujarat and Rajasthan. Found on saline waste and sandy tracts and depressions.

UTILIZATION

Reclamation—Can be grown on soils mentioned above for reclamation.

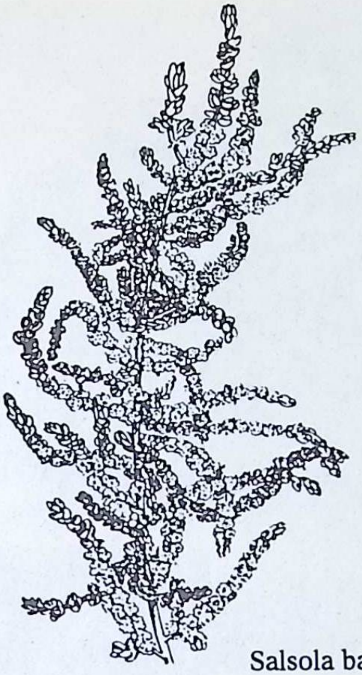
Fodder —Given to camels.

Others—Plant: A crude form of carbonate of soda (*sajji*) is obtained; vermifugal; ash applied to itches.

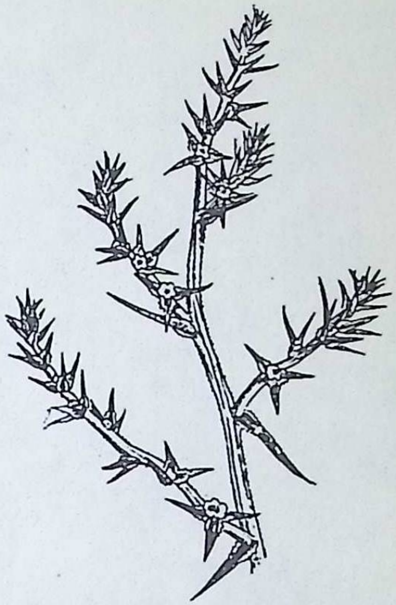
S. kali Linn. GLASSWORT, PRICKLY SALTWORT

Punjab–*Sajjibuti.*

Habit —A rigid, procumbent or diffusely branched, prickly herb or



Salsola baryosma



S. kali

spreading bush. *Leaf*—thick and fleshy,0.6–2.5 cm long. *Flower*—solitary and sessile, axillary, rose-coloured, sometimes appearing clustered due to reduction of axillary flowering branches.

Distribution—North-West Himalayas in Kashmir, at 3650–4250 m.

UTILIZATION

Reclamation—Recommended for reclamation of saline soils. A pioneer on coal-spoils.

Fodder —Eaten (protein, 11.66%) by sheep, horses and camels.

Others—Plant: Tender shoots boiled and eaten. *Leaf:* A source of crude carbonate of soda (*sajji* or *barilla*), used in glass-making. Used as anthelmintic.

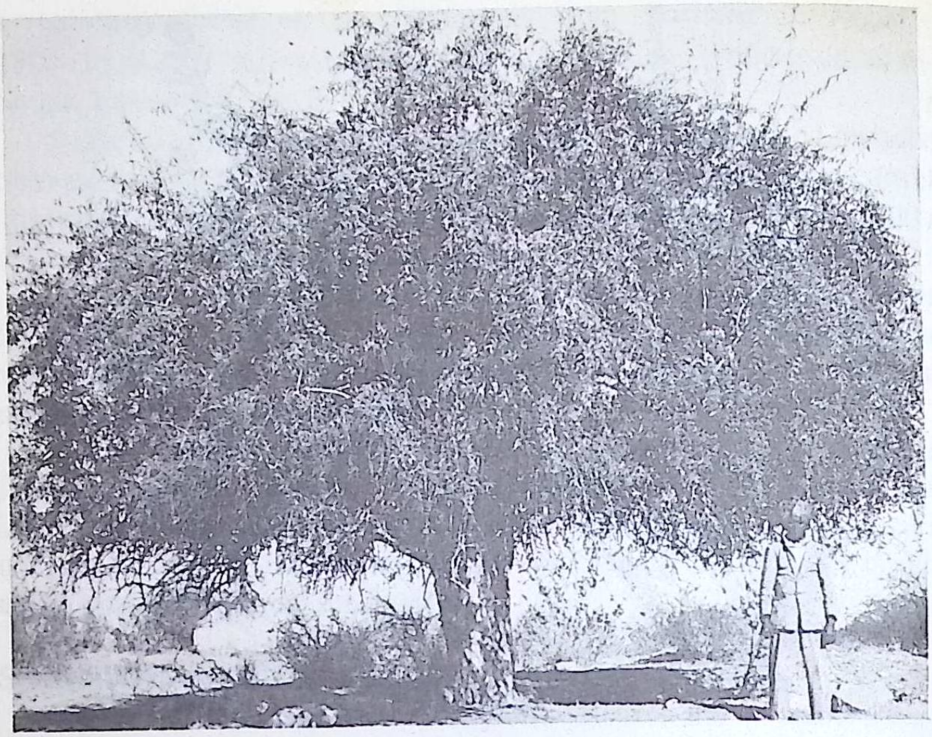
SALVADORA Linn. (*Salvadoraceae*)

Evergreen trees or shrubs; tropical Africa and Asia to Egypt, the Mascarene Islands and China; 2 spp in India.

S. oleoides Decne

Guj–*Khakan;* Hindi–*Bahapilu;* Mar–*Diar;* Tam–*Kalawa.*
Rajasthan–*Khabar*.

Habit—A pungent shrub or small tree, with twisted trunk and drooping



Salvadora oleoides

branches, 9–12 m. *Stem*—Often fluted. *Bark*—grey or whitish-grey. *Leaf*—linear-lanceolate, coriaceous. *Flower*—sessile, greenish-white, minute, in paniculate spikes; March–April. *Fruit*—globose drupe, usually yellow when ripe; June. *Seed*—greenish-yellow, *c* 3 mm in diam, 13,000/ kg; June; germination 70–100%.

Distribution and Ecology—Found in arid regions and mixed xeromphic woodlands in Rajasthan desert, on upper piedmont and buried piedmont plains, older alluvium with hammocky and undulating topography with a rainfall of 150–400 mm, semi-rocky or rocky sites. Found on saline soils, alluvial soils, moderately alkaline soils but with high exchangeable calcium, deep sandy soils and high mineral soils; also found along tidal creeks.

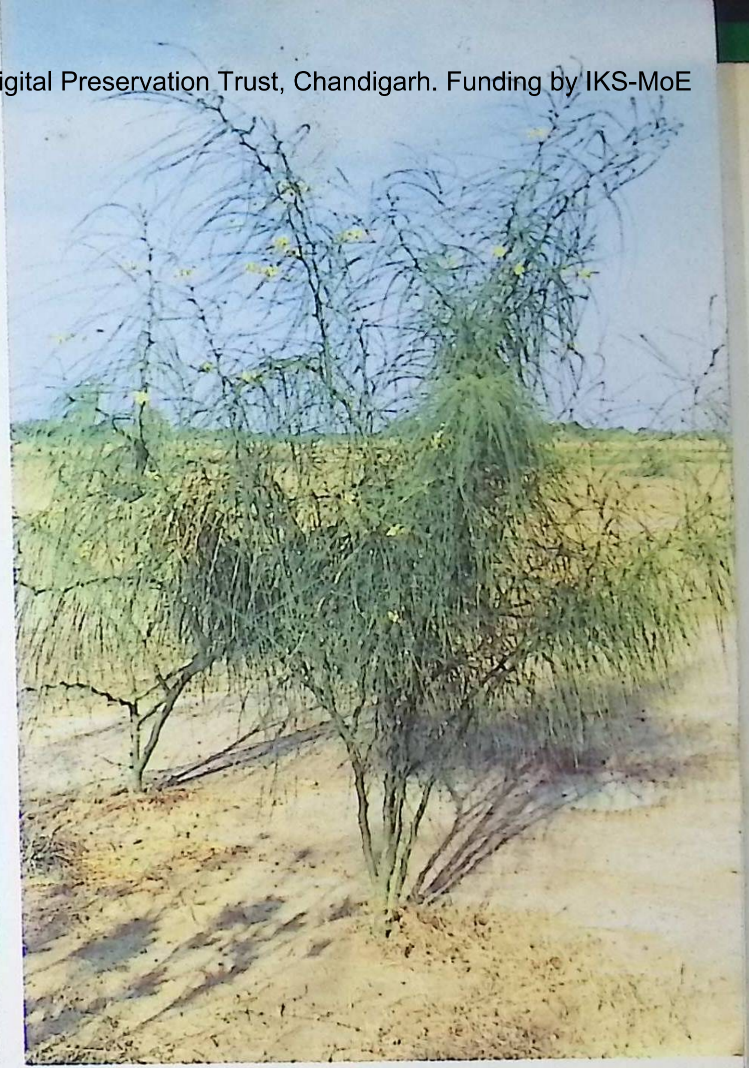
Silvicultural Characters—Suffers from frost, but little from grazing. Produces rootsuckers. Coppices fairly well.

Cultivation/Regeneration—Readily grows from seed and seedlings spring under the parent-tree. Besides, it freely regenerates from rootsuckers and to some extent by natural layers forming dense, impenetrable growth.

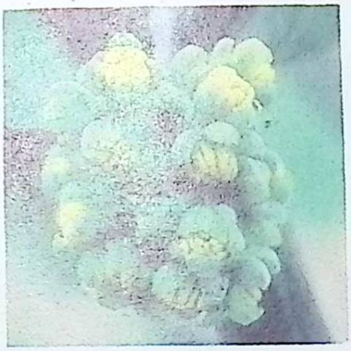
UTILIZATION

Reclamation—Recommended for afforesting different lands in arid

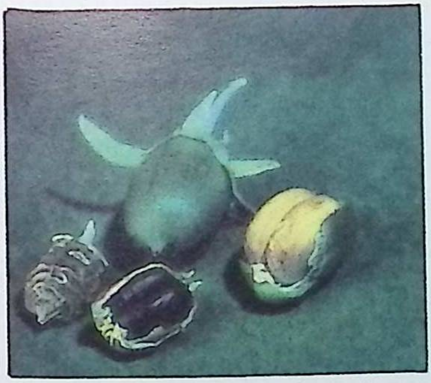
Parkinsonia aculeata



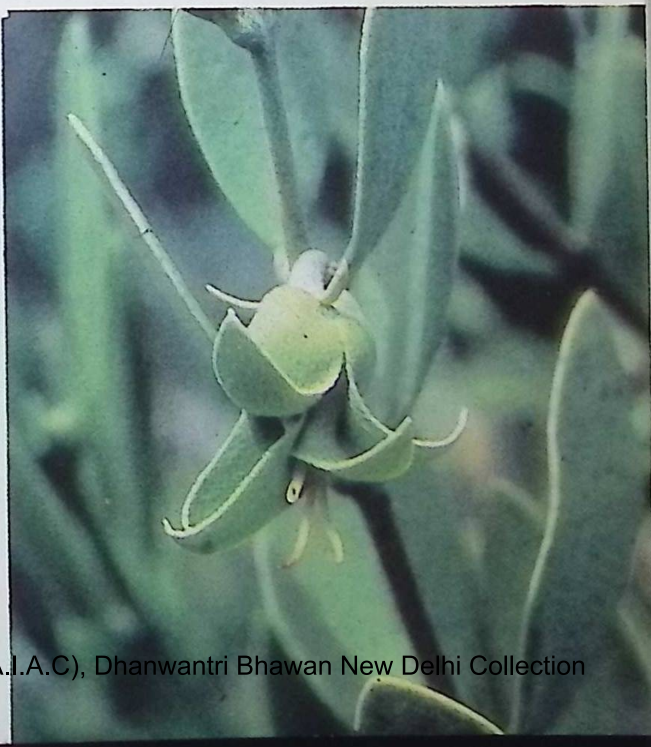
Simmondsia chinensis



Male flowers



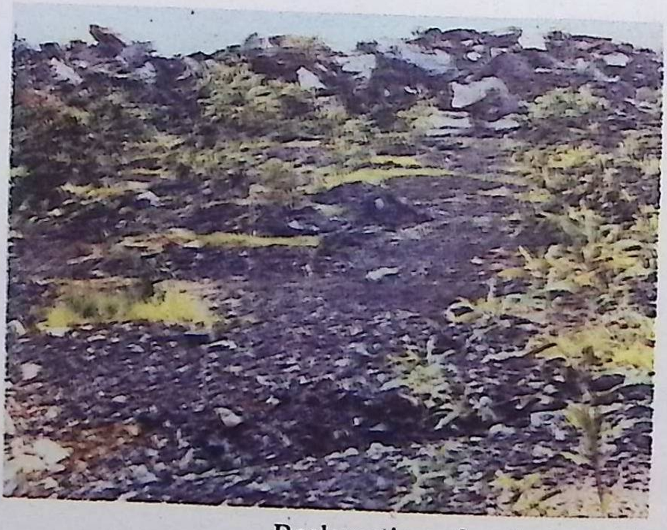
Fruit



Shoot with female flowers

Sesbania grandiflora

Yucca gloriosa



Reclamation of coalmine with *Acacia auriculaeformis* zone and to reclaim semi-rocky, rocky, sandy, saline areas and saline blanks and grasslands. Suitable for growing as shelterbelts and windbreaks in desert.

Timber—Building, agricultural implements, Persian wheels and boatknees.

Fuel—Though used, not a good fuel.

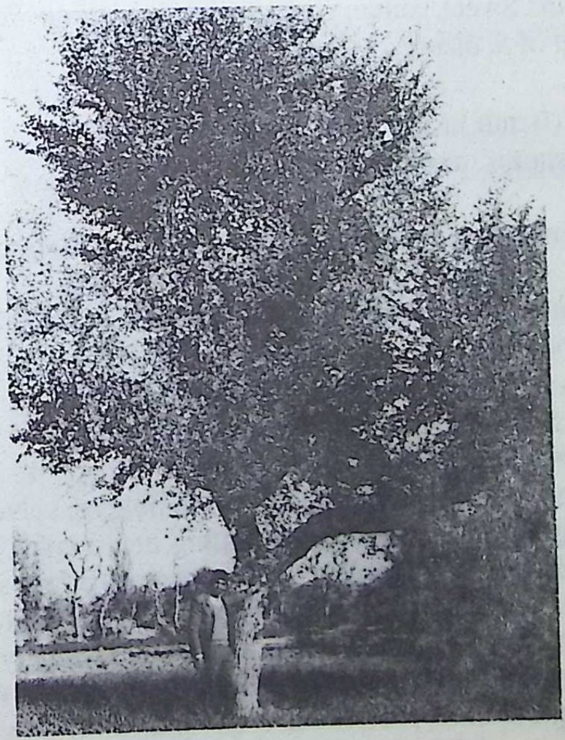
Fodder—Often lopped for camels (crude protein, 13.6%). Seedcake suitable as feed for livestock.

Others—*Leaf:* Used to relieve cough. *Seed:* Yields a fat (40–50%); a good source of lauric acid. Purified fat used for soap- and candle-making, and a potential substitute for coconut oil. Used in rheumatism and in suppositories. *Root:* Used in dental diseases, particularly to reduce toothache. *Seedcake:* Valued as manure for tobacco.

S. persica Linn. MUSTARD-TREE, SALTBUSH, TOOTHBRUSH TREE

Beng–*Jhal;* Guj–*Kharijal;* Hindi–*Kharjal;* Kan–*Goni-mara;* Mar–*Khankhin;* Oriya–*Kotungo;* Tam–*Kalawa;* Tel–*Varagoogu.*

Habit—A much-branched, evergreen shrub or tree. *Bark*—dull grey or grey-white, deeply cracked. *Leaf*—elliptic-ovate or ovate-lanceolate,



S. persica

somewhat fleshy. *Flower*—greenish-white or greenish-yellow, in lax panicles. *Fruit*—globose, round, smooth drupe, red when ripe.

Distribution and Ecology—Throughout dry and arid regions. Found on dry, arid regions, saline lands and coastal regions; also on salty dry lands; old alluvial sandy soils of Rajasthan, mineral soil, and deep sandy soils.

Cultivation/Regeneration—Tree readily regenerates from seed, but growth is slow. For transplanting, three-year-old seedlings from nursery are necessary.

UTILIZATION

Reclamation—Recommended for ravines, saline, alkaline, brackish-water areas and grasslands. Suitable and grown for windbreaks and shelterbelts.

Timber—Coffins. Burnt to repel mosquitoes.

Fuel—Not good.

Fodder—Lopped for camels.

Others—*Stem:* Used as toothbrush; beneficial in dental care. *Leaf:* Eaten as a vegetable; used for sauces; tender shoots eaten as salad. Decoction given in asthma and cough; poultice applied to painful tumours and piles. *Fruit:* Sweet, edible; yields a fermented drink. *Seed:* Yields a fat similar to that of *S. oleoides*.

SAMANEA (Benth.) Merrill (*Mimosaceae*)

Trees or shrubs; tropical America; 1 sp in India.

S. saman Merrill syn. *Enterolobium saman* Prain; *Pithecellobium saman* Benth.

THE RAINTREE

Beng–*Belati siris;* Hindi–*Vilayati siris;* Tam–*Thungumoonji;* Tel–*Nidraganneru.*

Habit—A large, fast-growing, evergreen or deciduous tree, 18–24 m. *Stem*—short, with a very broad and widespreading crown, branchlets velvety. *Bark*—grey. *Leaf*—large, bipinnate, 2–6 pairs: leaflets 8pairs, oblique, oblong-rhombic to obovate or ovate-oblong, velvety beneath, up to 3.2 cm long, terminal the largest, folding or drooping at night or on approach of rain. *Flower*—solitary, yellowish, with pink stamens, grouped in semi-circular, globose heads, up to 5 cm diam; April–May. *Fruit*—glabrous, flattened, sub-terete, thick-margined, leathery-fleshy, 10–12-seeded pod, 15–20 cm × 1.25–2.5 cm. *Seed*—embedded in sugary, edible pulp; 6407/ kg; March–April; needs soaking in cold water for 24 hrs.

Distribution and Ecology—Native to tropical South America. Cultivated in warmer parts of India, particularly on roadsides for shade and ornament. Not particular about soil but thrives best in hot, moist localities. Does not withstand cold.

Cultivation/Regeneration—Easy to grow from seed and cuttings; withstands lopping and pruning.

UTLIZATION

Reclamation—Can grow on dry and barren soils, but tends to branch low; not particular about soil. Suitable for reclaiming swampy areas and grassy blanks. Fixes nitrogen. Valued as a shade-tree for vanilla, coffee, nutmeg, cacao, patchouli and pepper, and in agroforestry practices.

A good host for epiphytes; also for lac-insect.

Timber—Carts, toolhandles, and agricultural implements.

Fodder—Leaf good for livestock, particularly tender ones (crude protein, 10.22%). Fruit a very valuable feed; contains rich, sugary pulp; improves the quality of milk. Available when other feeds are not; dried ones can be stored.

Others—*Bark:* Yields gum. *Leaf:* Used as green manure. *Fruit:* Useful for producing alcohol. *Seed:* Yields an oil (4.8–8.5%).

SAPIUM P. Br. (*Euphorbiaceae*)

Monoecious or dioecious, laticiferous trees and shrubs; the tropics, chiefly in America; 6 spp in India.

S. sebiferum Roxb. THE CHINESE TALLOW-TREE

Beng–*Mom-china;* Hindi–*Vilayati-shisham;* Kan–*Meenadabattimara;* Oriya–*Ronojita.*

Habit—A deciduous, fast-growing tree, 18 m/2.4 m. *Stem*—often gnarled. *Bark*—grey, with vertical cracks. *Leaf*—rhombic-ovate or orbicular-ovate. *Flower*—monoecious, greenish-yellow, very fragrant in terminal, drooping racemes; male clustered in the upper portion of inflorescence; female below, larger; June–August. *Fruit*—subglobose, fleshy, capsule 1.0–1.3 cm, 3-seeded; November–January. *Seed*—enclosed in a thick coating of white, aril-like, fatty substance; 16,000/ kg; germination 70–100%.

Distribution and Ecology—Native to China, largely cultivated in northern India, up to 1800 m in the Himalayas. Also planted throughout India for ornament. Found on gravelly soils in ravine-lands in the foothills, moist soils on hills as in Himachal Pradesh and on river-islands on the plains.

Silvicultural Characters—Withstands certain amount of shade. Frost-hardy. Produces rootsuckers in abundance. Coppices very well, and able to survive on grazing-grounds as it is not grazed.

Sapium sebiferum

CULTIVATION/REGENERATION

Natural Regeneration—Freely regenerates from seeds; also produced in plenty through rootsuckers and has run wild in some parts.

Artificial Regeneration—Easily raised from seeds, cuttings and the suckers.

UTILIZATION

Reclamation—Recommended for fixing the sides of ravines, river-banks and waterlogged areas; adapts well to poorly drained and saline soils and yields large biomass. Recommended for social forestry.

It is a possible petrospecies.

Timber—Toys, furnitures, inferior-quality pencils, cricket-bats, and blackmounts.

Fuel—Used as firewood.

Fodder—Leaf is given to eri-silkworms. Seedcake a valuable feed and possesses high content of protein. Defatted seedhulls can also be fed to cattle.

Others—*Latex:* Acrid and powerful vescicant. *Leaf:* Yields a black dye and tannins (5.5%). *Rootbark:* Considered tonic.Decoction given in dyspepsia; resin purgative. *Fruit:* Seed-coating yields a tallow (55–78%); resembles cocao-butter; edible if properly refined. Used for candles, cosmetics, soaps, dressing cloth. On burning, gives a smokeless flame. Substituted for animal tallow, and mixed in small quantities with edible oils for stiffening. Can be used as a substitute for diesel. *Kernel:* Yields an oil (53–64%), called STILLINGIA OIL; considered superior to linseed; used in paints, cosmetics and plastics, and as an illuminant. Oil vulnerary, emetic and purgative. Used to adulterate tung oil. *Cake:* Can be processed into a refined flour-protein (75%), fit for human consumption. Also a valuable fertilizer.

SESBANIA Adans. Corr. Scop. (*Fabaceae*)

Herbs, shrubs and soft-wooded but short-lived trees; tropical regions; 6 spp in India.

Sesbania spp have soil-improving properties, but their use as ground-cover to prevent erosion may be limited. Some are notworthy for livefences, supports, shade and as windbreaks. Some yield fibre, gum and oil. A few species are excellent for forage and fodder. They fix nitrogen.

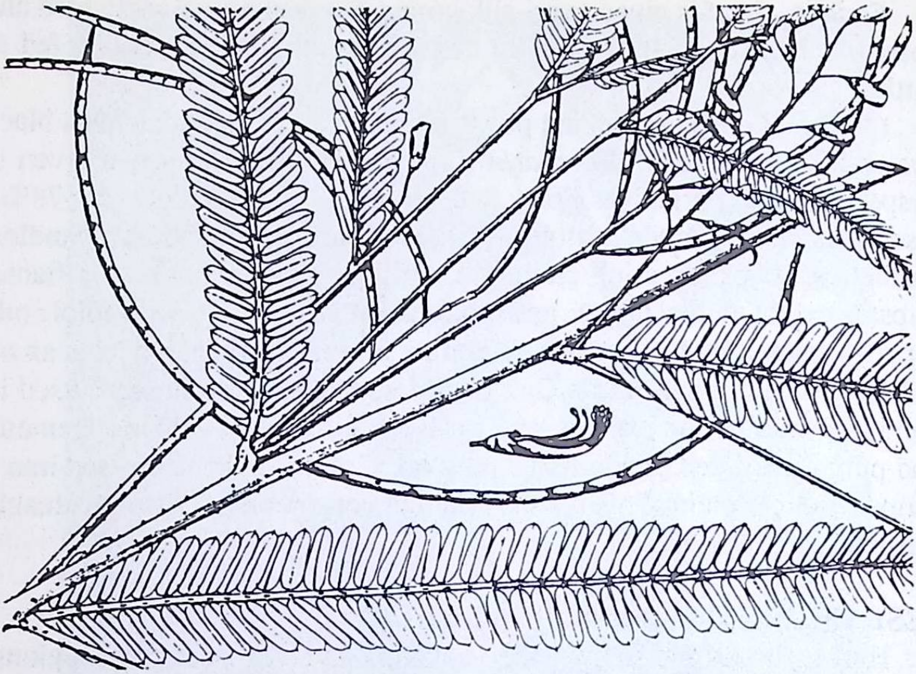
S. cannabina (Retz.) Pers. syn. *S. aculeata* Pers.; Baker (Fl Br Ind) in part var. *cannabina* Baker PRICKLY SESBAN, DAINCHA

Guj–*Sasiikad;* Hindi–*Dhunchi;* Kan–*Mullajeerangi;* Mal–*Kitannu;* Mar–*Ran shevari;* Oriya–*Dhaincho, tentua;* Sans–*Jayanti;* Tam– *Mullaagathi;* Tel–*Errajeeluga.*

Assam–*Dhaincha;* Punjab–*Jhiyan.*

Habit—A tall, fast-growing, succulent, erect, suffruticose, shrubby annual. *Stem*—smooth, sparingly prickly, green, with red stripes, branching from base, producing lateral roots in stagnant water for firm grip. *Leaf*—alternate, abruptly pinnate: leaflets numerous, linear, oblong, glabrous. *Flower*—yellow, mottled, with brown or red to black, 1.2 cm long, in 3–4-flowered racemes. *Fruit*—straight or slightly curved, torulose, 15–25 cm long pod. *Seed*—1000–1600/kg; viable for 3–4 years if properly stored; needs soaking for 12 hrs; treated against insects.

Distribution and Ecology—Native to Australia, widely cultivated almost throughout India, up to 1200 m, during the rainy season, particularly



Sesbania cannabina

to reclaim the alkaline, saline and waterlogged areas. Besides its cultivation, found in marshes and swamps and riverain areas on almost all types of soils and climate. Grows well on loamy, clayey, black and sandy soils. Withstands 60 cm submergence for 7days and grows to 1.5–1.8 m in a short time. Highly drought-resistant.

Cultivation/Regeneration—A monsoonal crop, propagated from seed either broadcast (90–110 kg/ha) or drilled (20–60 kg/ha), 30 cm apart, on ploughed and levelled ground during May–July, depending upon the main crop; higher seedrate gives thicker stand. Needs 5–6 irrigations for 45-day-old crop. Though not manured, responds to farmyard manure and fertilizer. Can be ploughed *in situ* when 6–7-week-old. Not seriously damaged by fungi, but a few borers, leaf-webbers and caterpillars cause damage. Irrigated crop usually yields three cuttings.

UTILIZATION

Reclamation—With the vigorous rootsystem, the plant can be grown on almost any type of soil from heavy to sandy soil, with low *p*H and alkaline, saline and waterlogged soils for reclamation; recommended for social forestry. Withstands high rainfall and competition from weeds and highly drought-resistant; recommended for green manure and reclamation of soils. On new alkaline soils (*p*H 10.6), with gypsum or rock phosphate and good water for leaching, it gives large biomass as on normal soils. Vigorous root-noduling in all types of soils including highly saline and alkaline soils and fixes nitrogen. Improves the fertility. Grown as cover-crop in cocount, mango and cocao plantations, as a windbreak for paddy and betel, as a standard for betel, and for shade in tea and coffee plantations.

Green Manure—Quick-growing, succulent, easily decomposible with low requirement of moisture, and produces maximum organic matter and nitrogen; improves the tilth and water-holding capacity and availability of salts and trace elements. Yields of paddy, wheat, sorghum, sugarcane, cotton, tea and coconut increase.

Fodder—Suitable for poultry and cattle (protein, 2.6%) and can be converted into silage; can be grown along with non-leguminous plants. Kernel and husk may be used for preparing cattle- or poultry-feed.

Others—Plant: Employed for making rice-paper. *Seed:* Yields a gum (crude protein, 37.67%; gum, 28%) similar to that from *guar* and may have industrial use for sizing in textiles and as wet additive in paper-making. *Cake:* Contains 53.46% protein; substituted for groundnut meal for culture-medium for the growth of *Penicillium.*

S. grandiflora Pers. Swamp-pea, Agathi

Beng–*Agati*; Guj–*Agathio;* Hindi–*Agasti;* Kan–*Agase;* Mal–*Mathi;* Mar–*Magda;* Oriya–*Ogosti;* Tam–*Agathi;* Tel–*Avisechettu.*

Habit—A short-lived, quick-growing tree, 6–9m/60cm. *Leaf*—15–30 cm long, abruptly pinnate: leaflets 41–61, linear oblong, glabrous, 2.5–5.0 cm × 0.5–1.6 cm. *Flower*—white, pink or crimson, showy, fleshy, sweet, 6.0–10.0 cm long, in short, axillary, 2–4-flowered racemes; September–December. *Fruit*—pendulous, 4-armed, non-torulose, septate, 15–50-seeded pod, with swollen margins, hot season. *Seed*—pale-coloured.

Distribution and Ecology—Native to Malaysia, grown in many parts of India, including the Andamans, up to 1000 m. Grows on a variety of soils, but best on black cotton-soils. Drought-resistant.

Cultivation/Regeneration—Self-productive on loose and uneven surface. Directly grows from seed. For standards, the seed is sown in two long rows and watered; 3–4 seeds are sown for shade during June–July per hole in a narrow channel of 30 cm × 30 cm dug at a distance of 0.9–1.2 cm from coconut seedlings. Initial stages need light watering for germination and growth. Excess seedlings removed; side branches pruned to make the main branch thick and woody in one year, forming almost a hedge. Planted in

2–3 close rows, as a windbreak for banana. A few diseases and pests have been recorded attacking the tree at various stages.

UTILIZATION

Reclamation—A drought-tolerant tree, suitable for wastelands. Can be used for afforestation of eroded soils. Fixes nitrogen. Recommended for agro- and social forestry and as windbreak; grown as a support- and shade-tree for pepper, betel and coconut nurseries, and for ornament.

Timber—Toys, posts; and pulp.

Fuel—Used as fuelwood. Yields charcoal useful for gunpowder.

Fodder—Shoots and leaves (protein, 33.4%) are available during dry season and relished by livestock and poultry.

Others—Bark: Powder used as cosmetic. Yields a good fibre; used for cords. Exudes a gum, substituted for gum arabic. Juice used for tanning and toughing the fishing-net and for coloured matting. Astringent; given in diarrhoea and dysentery and other stomach disorders. *Leaf:* Eaten as vegetable and salad; contains important vitamins and minerals. Protein considered to be of good quality. Contains pectin (1.47%). *Flower:* Eaten as vegetable (protein, 1.8%) and salad; a good source of vitamins; pods also eaten. *Seed:* unpalatable and toxic (protein, 36.5%); protein can be used as fillers in casein and other glues.

S. sesban Merrill syn. S. *aegyptiaca* Pers. COMMON SESBAN

Beng & Hindi–*Jainti;* Guj–*Jayati;* Kan–*Arisinajeenangimera;* Mal–*Sempa;* Mar–*Jayati, shewarie;* Oriya–*Joyontri;* Sans–*Jayantika;* Tam–*Chittagathi;* Tel–*Samintha.*

Assam–*Jayantri;* Punjab–*Jaint.*

Habit—A soft-wooded, quick-growing, short-lived shrub, up to 6 m. *Leaf*—paripinnate, 7.5–15.0 cm long: leaflets 8–20 pairs, linear-oblong, glabrous, entire, 6.0–25.0 mm × 2.5–6.0 mm. *Flower*— yellow, yellow-spotted to red-purple, standard petal coloured purple or brown from outside, in 8–10-flowered, lax, axillary, racemes. *Fruit*—distinctly torulose, weak, pendulous, twisted, sharply beaked, 20–30 -seeded pod, 12.5–22.5 cm × 0.25–0.37 cm.

Basing upon the colour of the flower, var. *sesban*, var. *picta* Sant. and var. *bicolor* F.W. Andr. have been distinguished.

Distribution and Ecology—Cultivated throughout the plains of India up to 1200 m. Grows under widely different conditions, producing large biomass; grows under waterlogged conditions and acidic soils; withstands concentration of salts up to 1.4%. Leaves and pods dry due to frost.

Cultivation/Regeneration—Directly sown in rows at *c* 30 cm for windbreaks parallel to orchards. For support to sugarcane, sown in equidistant rows along with sugarcane and each plant becomes a support for six canes. As a green manure, it can be grown pure; also grown as a perennial green-manure crop. Yields fairly good biomass.

UTILIZATION

Reclamation—Recommended for waterlogged, arid, saline and alkaline soils; also for social forestry. Commonly cultivated as a shade- and nurse-tree for coffee, turmeric, cotton, tea, sweet orange and mandarine. Used as a windbreak, support for betel, pepper and grape and cucurbitaceous plants and sugarcane. Fixes nitrogen.

Green Manure—Rich in nitrogen (4%) and excellent for paddy, sugarcane and *ragi;* can also be converted into compost; easily nitrifies the soil. Improves the humus by 33%; decreases the salt if grown for three years on saline soils and improves productivity and physical conditions.

Timber—Toys, huts; and pulp.

Fuel—Good firewood; used in jaggery-making; charcoal suitable for gunpowder.

Fodder—Young shoot lopped; leaf a good source of protein (26.6%), calcium and phosphorus.

Others—Bark: Yields a fibre; suitable for ropes. *Leaf:* Eaten. *Flower:* Shows antifertility activity. *Seed:* Yields an oil (5.3%) and tannins (4.2%). Astringent; useful in diarrhoea.

S. speciosa Taub.

Tam–*Seemaiagathi.*

Habit—A perennial shrub, with pubesecent branches, 3.6 m. *Leaf*—densely pubescent, pinnate, 30–55 cm long; leaflets 40–60, each 1.6cm long. *Flower*—large, yellow spotted with purple, in axillary pendent, 6–20-flowered racemes. *Fruit*—light brown, with thickened sutures, many-seeded, 25–30 × 0.8 m. *Seed*—does not possess dormancy; germination 33–45%; requires soaking in hot water at 80°C for 10 min or at boiling-point for 5 min; or scarification with sand.

Distribution and Ecology—Native to Kenya, introduced into India; cultivated in Andhra Pradesh, Tamil Nadu and Orissa. Grows on many types of soil, resists drought and waterlogging. Withstands saline and moderately alkaline soils. Develops roots for support when grown in waterlogged areas.

Cultivation/Regeneration—Propagated from seed; no elaborate preparation of land needed. Sown broadcast (17–56 kg/ha) or drilled (20–60 kg/ha) all round the year in rows 30 cm apart; for green manure grown in April and November; for shade, October–November.

Raised as pure crop (56 kg/ha) for fibre in September. For green-manuring second crop of paddy, 45–60-day-old seedlings of 30 cm are transplanted at 5–20 cm apart on bunds. For seed, planting is done at 30–60 cm and the plants are pruned for better branching and fruiting. Irrigation benefits the crop.

UTILIZATION

Reclamation—Recommended for reclaiming alkaline, saline and waterlogged soils, and is better than *S. cannabina*. Fixes nitrogen. Recommended to be grown on lateritic soils of Kerala with lime, phosphoric acid and farmyard manure. Valued as a border- and shade-plant for paddy, wheat, sugarcane and cocount seedlings. Withstands drought and not grazed by cattle.

Green Manure—Does not become woody; produces very large biomass in only 2–3 months and decomposes in 3–5 days with high nitrification and provides major nutritents to the soil. Increases the yield of paddy on alkaline wet soils by *c* 22%; wheat, sugarcane, coconut, irrigated *ragi* are also manured.

Timber—Probably suitable for paper.

Others—*Stem:* Yields the best-quality fibre before flowering; used for ropes.

S. bispinosa W.F.Wight syn. *S.aculeata* Pers. Baker (Fl Br Ind) in part (excl. vars.) (Rajasthan–*Ikad*) is an erect shrub, with red, prickly stems, found as a weed in the paddy-fields or gregariously growing in waste places including waterlogged areas, more or less similarly used as S. *cannabina*. Fixes nitrogen. Can be used as green manure in paddy- and wheat-field. Suitable for reclaiming sodic soils. Shrub used to cure wounds. Seed applied to ringworm.

S. roxburghii Merrill syn. *S aculeata* Pers. var. *paludosa* Baker (Fl Br Ind) in part (Beng & Hindi–*Kathsola;* Kan–*Kareejeenangi*) is an erect annual, 1.8–3.6 m, native to South-East Asia, occurs in lakes in West Bengal and in marshes of the west coast; grown as a fence. Fixes nitrogen. Wood used for toys; leaf eaten and also fed to cattle. Seed yields an oil (3.78%).

SIMMONDSIA Nutt. (*Simmondsiaceae*)

Dioecious shrubs; native to arid zone Arizona, California, in the USA and northern Mexico; 1 sp introduced into India.

S. chinensis (Link) Schneid. JOJOBA, GOAT- OR SHEEP-NUT, WILD HAZEL

Habit—An evergreen, multistemmed, woody shrub, with stiff branches, sometimes more than 4.8m on moist sites, semi-prostrate in desert areas. *Rootsystem*—very deep, at least 10.5 m. *Leaf*—oblong-ovate, sub-sessile, 2–4cm long, leathery, grey-green, covered with a wax which reduces loss of water and prevents fungal infection. *Flower*—generally solitary, but sometimes up to 20 in a fascicle: male yellow, 3–4 mm long; female silvery-green, leaf-like, 10–20 mm; urn-shaped; September–October; December–April. *Fruit*—generally 1, rarely 2 or more in clusters at nodes, greenish turning brown, coriaceous, obtusely 3-angled, nut-like capsule, up to 3 cm long, filled with large, oily, puberulent seeds occupying maximum percentage; generally 1-seeded though found with 1–3 seeds; July–October. *Seed*—tough, leathery, brown, varies in size, colour and shape, containing free-flowing liquid wax when cut; 700–5300/kg; germination 9–15 days, 0–100%; retains viability for long; needs soaking for 24 hrs.

Distribution and Ecology—Native to southern USA and northern Mexico, from sealevel up to 1500 m, very recently successfully introduced into India; efforts are being made for its large-scale cultivation and 3.5 ha have already been raised in Gujarat. Withstands extremes of temperature of desert as high as 50°C (43–46°C in the shade) and with no adverse effect and in areas with 12.5–45.0 cm rainfall; mature plant survives at –9°C.

Although grows on a variety of soils from porous rocks to clay and from sealevel, it grows best on well-drained, well-aerated, coarse, desert-soil and coarse mixture of gravel and clay. Highly tolerant to saline and alkaline soils. It, however, cannot grow on wetlands, low lands and marshy areas. Successfully cultivated on coastal sand-dunes in semi-arid zones of Gujarat and sub-humid regions of coastal Orissa. Also, experimentally cultivated in the arid and wasteland tracts of Rajasthan and Uttar Pradesh.

Cultivation/Regeneration—Can be raised from seed, rooted cuttings, air-layering, and from tissue-cultured plantlets. Soaked seed directly sown in 45 cm pits filled with treated farmyard manure and weathered soil, at 2 m × 3 m, in October; excess water decays the seeds; also seedlings, sown in October in bags, transplanted; by July, 15–25 cm seedlings ready for transplanting during monsoon. Young plant is susceptible for transplanting. Vegetative propagation of female plant by air-layering is recommended. Commercial yields of fruits can be obtained after six years and increase with age (8–12 years) and remain fairly constant. Urea (2 g/plant) has been recommended. Requires frequent irrigation during the first 1–2 years and later one life-saving irrigation under the Indian conditions. Spacing density and male–female ratio (1:7 to 1:4) and their positions are important for good yield; hand-pollination has also been suggested. Early fruiting within 3 months in subhumid and semi-arid coastal climate as compared with 5–7 years in the USA indicates its suitability to the Indian conditions. Yield is expected to be between 800 and 3000 kg/ha. Believed to survive up to 200 years. Intercropping is possible in the initial 3–4 years. For uniform yields and commercial plantations, stem-cuttings from choice-plants have been recommended.

UTILIZATION

Reclamation—Recommended for reclaiming several types of soil. Thrives well on wastelands and wasted and exhausted lands, and these can be reclaimed. Grows well and withstands extremely harsh conditions. Besides the soils already discussed above, it can be grown in salty areas with even up to 10,000 ppm and such water also can be used for irrigation of jojoba.

Reported to be a petroplant.

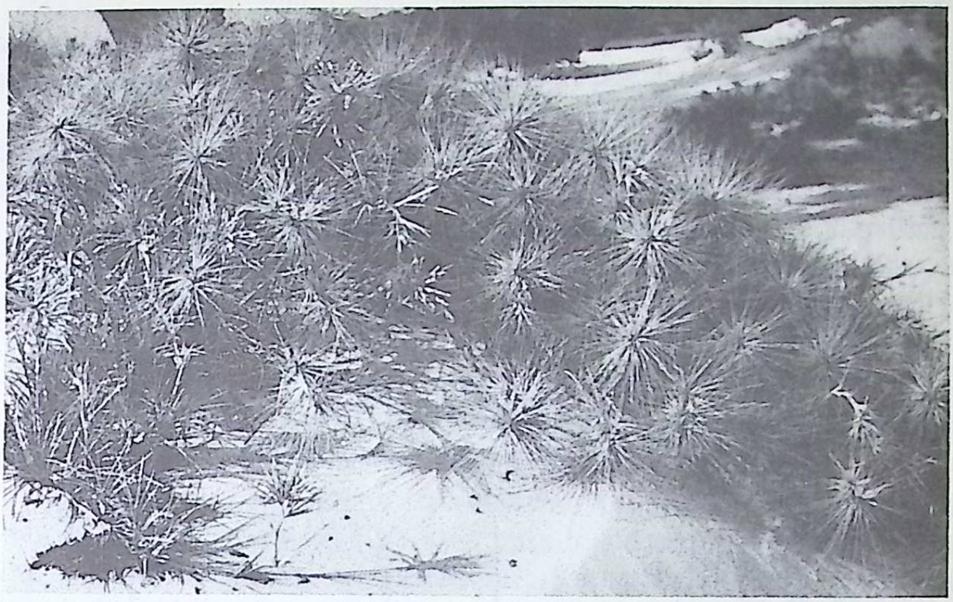
Fodder—A valuable plant; withstands grazing by cattle, deer, sheep and goats. Treated seedcake can be given to livestock.

Others—Seed: Yields a liquid wax (45–60%), JOJOBAOIL, very similar in chemical composition and characteristics to SPERMWHALE OIL and an ideal substitute; does not become rancid even after 25years and does not degrade even at 300°C. Non-volatile, non-toxic and unsaturated, and non-triglyceride, it possesses anti-wear and extreme-pressure characters, and a good friction-modifier; can be used as an intermediate in the preparation of numerous other compounds, lubricants, disinfectants, detergents, driers, emulsifiers, candles, carnauba, base for creams and ointments, in cosmetics, such as hairoil, shampoos, face-creams and soaps, and in pharmaceuticals and leather industry. Reacts with sulphur to form compounds with wide-ranging properties from oils to rubbery solids, adhesives, varnishes, linoleum and printing-ink; hydrogenated wax is used for floor-finishes, carbonpaper, and polishes for furniture, shoes and automobiles. *Cake*—Potential feed (protein, 26.35%); lysine content good, though poor in methionine. Contains a toxic substance, simmondsin, which can be removed by ammonia treatment.

Reported that a crop from one hectare can save 125spermwhales !

SPINIFEX Linn. (*Poaceae*)

Stout, rigid, littoral, perennial, bushy grasses of sandy shores and deserts; Indo-Malayan Archipelago, China, Japan and Australia; 1 sp in India.



Spinifex littoreus

S. littoreus Merrill syn. *S. squarrosus* Linn. WATER-PINK

Kan–*Raavanamiesehullu;* Oriya–*Gundukanko;* Tam–*Ravananmeesai;* Tel–*Raavanaasuridimeesaalu.*

Habit—A squarrose, suffruticose, pale-green, dioecious grass, forming impenetrable bushes, 0.6–1.2 m. *Stem*—long, smooth, solid, woody, thick below, freely branching, 1.5–3.0 m or more. *Leaf*—rigid, narrow, thickly coriaceous, recurved, involute, margins spinulose-serrulate, 10–15 cm long. *Male inflorescence* —2.5–7.5 cm spikes, 2.5–7.5 cm long, forming umbels. *Spikelet*— several, 2-flowered. *Inflorescence*—female in large globose head of short spikes. *Spikelet*—solitary 2-flowered. *Seed*—clavate, free within the hardened glumes.

Distribution and Ecology—On the coast from Gujarat to Konkan and from West Bengal to Kanniya Kumari and in the Lakshadweep. Luxuriant on the east coast. Cultivated on the coast of Tamil Nadu. Grows on sandy shores, sand-dunes and in deserts.

UTILIZATION

Reclamation—An excellent sand-binder on coastal saline soils and other areas, but useless as fodder.

Extensively cultivated on the coast of Tamil Nadu to control the movement of sand and as windbreak and hedge.

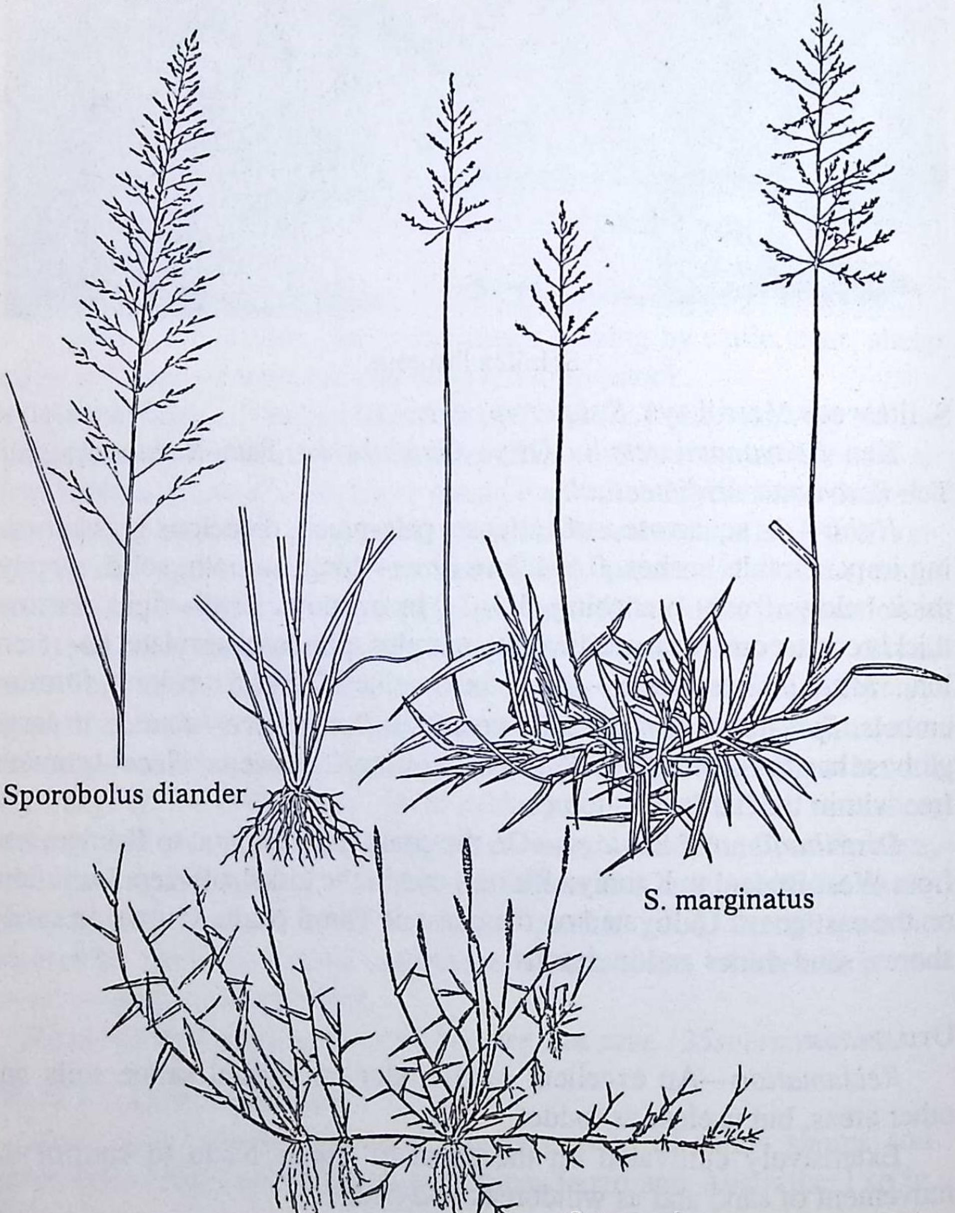
Fuel—Dried grass used as fuel.

SPOROBOLUS R.Br. (*Poaceae*)

Annual or perennial grasses, known as Drop-seed Grass, native to Asia, Africa, America and Southern Europe; 10 spp in India. Some are suitable for wastelands.

S. airoides (Torr.) Torr. is a tall, perennial grass, introduced from the USA. Can easily be grown in saline and alkaline tracts for reclamation, particularly the latter. Reported to be one of the best for grazing.

S. diander Beauv. (Beng–*Bena-joni;* Hindi–*Chiriya-ka-dana;*



Kan–*Naviludendihullu;* Delhi–*Doob;* Punjab–*Nonak*) is a tall, erect, slender annual or perennial, 30–90 cm high, with densely tufted leaves, pyramidal panicles and oblong, chestnut-brown grain, found growing in small tufts in dry places throughout India, up to 2100 m; common in moist gravel during rains. Suitable for arid regions and a good soil-binder. Highly relished fodder (crude protein, 6.45%). Used for brooms.

S. helvolus Dur. & Schinz. syn. *S. glaucifolius* Hochst. ex Steud. is a densely tufted perennial, 30–45 cm high, with 12 cm long leaves and pale-yellowish panicles, found in drier regions of Punjab and Gujarat and on Konkan coast, usually in sandy saline land and fallow-fields. Can be grown for reclamation of saline and alkaline soils and coastal saline soils and in grass- and rangelands. Serves as a fodder (crude protein, 16.18%). Crushed plant is added to tea and given as a cure for malaria.

S. maderaspatanus Bor syn. *S. orientalis* Kunth (Hindi–*Usar-ke-ghas*) is a vigorously growing stoloniferous grass, found throughout Punjab, Uttar Pradesh, Rajasthan, Gujarat, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. Grows in sandy or saline soils, and also as shelterbelts for controlling coastal sand-drift. A good fodder for horses and cattle; also makes good hay.

S. marginatus Hochst. ex A. Rich. syn. *S. arabicus* Boiss. is an erect, stout, perennial, with woody stolons, found in Punjab and North-West India, up to 2100 m. A common grass of dry habitats along roadsides and *usar* lands. Reported to have high tolerance to salt; can be grown for reclamation of saline, alkaline and coastal saline soils. A good fodder (crude protein, 9.11%).

S. spicatus (Vahl) Kunth is a perennial grass, with woody stolons, which spread, sending up tufts of very stiff culms, found in the Deccan peninsula. Propagated from seeds and stolons on sand-dunes. A good sand-binder, and fodder.

S. tremulus (Willd.) Kunth (Tam–*Uppurutnampillu, koilpatti)* is a stoloniferous grass, with erect or ascending culms of 3–7 cm, found in the plains from Punjab to West Bengal and in Tamil Nadu, up to 750 cm. Grows in sandy moist areas and along grassy blanks of ponds. A good soil-binder and common pasture- and fodder-grass (protein, 6.06%).

S. virginicus (Linn.) Kunth is a perennial grass, found in Gujarat and Maharashtra. Grows on sandy seashores and a good sand-binder in coastal sand-drift areas; suitable for growing on acid metalliferous soils.

STYLOSANTHES Sw. (*Fabaceae*)

Perennial herbs or undershrubs; tropical and sub-tropical America and

Africa and to some extent in tropical Asia; 6 spp in India; 5 introduced for forage.

Stylosanthes spp, popularly called as STYLO, are useful and widely adaptable and now occupy a special place in dairy-pasture improvement and livestock production in the dry, infertile and native grass-pastures of different tropical and sub-tropical countries of the world. The seeds are small with hard seedcoat (germination 60–90%) and need pretreatment for better germination with conc. sulphuric acid or hot water. Cultivation of these species for the reclamation of wastelands, degraded areas can be taken up with successful results.

S. fruticosa Alston syn. *S. mucronata* Willd.; *S. bojeri* Vog. WILD LUCERNE

Tel–*Saillekampa.*

Habit—A procumbent herb or undershrub, with woody rootstock and terete, pubescent branches; 20–30 cm. *Leaf*—pinnately trifoliate: leaflets oblong or lanceolate, mucronate. *Flower*—yellow, in sessile, terminal heads or spikes. *Fruit*— hard, 1–2-seeded pod.

Distribution—Dry localities of Orissa, Andhra Pradesh, Karnataka, Tamil Nadu and Kerala, up to 900 m, and on the coasts; also grown at Palampur, Himachal Pradesh.

UTILIZATION

Reclamation—Can be used for the reclamation of grasslands and rangelands.

Fodder—Leaf a good fodder (crude protein, 17.7%); can be converted into hay (crude protein, 12.22%). Also used for diarrhoea and colds.

S. guyanensis (Aubl.) Sw. ssp. *guyanensis* syn. *S. gracilis* H.B. & K. STYLO, BRAZILIAN LUCERNE, TROPICAL LUCERNE

Ranchi (Bihar)–*Grampasand.*

Habit—A sub-erect, perennial herb or scandent shrub, arising from a central rootstock, with several runner-like branchlets, developing shallow roots at a few nodes, up to 1.2 m. *Leaf*—pinnately-3-foliate. *Flower*—creamy-white, in dense terminal heads. *Fruit*—pod, glabrous. *Seed*—shining, blackish-purple; germination 50–70%.

Distribution and Ecology—Introduced into India from South America, cultivated in Assam, West Bengal, Bihar, Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and the Andaman Islands. Shows a wide range of adaptability and found in arid conditions, and on extreme acidic, saline-alkaline and waterlogged areas. Highly drought-resistant but frost-susceptible; tolerates waterlogging fairly.

Cultivation/Regeneration—Pretreated seeds may be broadcast/sprinkled (2–4 kg/ha) just before the monsoon; may also be broadcast even under the thin canopy of the forest.The two cultivars 'IGFRI- S-4214' and 'IGFRI-S- 96-1' are promising. Can be grown with grasses, such as Para, Nandi, Rhodes, Guinea, Dinanath and Thin Napier, in wet areas. Also can be grown in the interspaces

Yield—The above cultivars yielded 432 and 416 qt green fodder/ha, respectively, in two years in monoculture with an average dry matter of 25%. In association with buffelgrass, the yield of both was, however, 536 and 535 qt green fodder/ha, respectively, in two years.

UTILIZATION

Reclamation—Most promising and suitable for the reclamation of arid, extremely acidic, saline and alkaline and waterlogged areas. Also suitable as ground-cover for terrace faces in Cachar and Darjiling and for eastern low hills and southern plateau. Helps to keep the exposed faces covered and prevents soil-erosion.

Fodder—Leaf very good fodder for cows, murrah buffaloes and whiteleghorn birds. Combines well with Guinea-, Napier- and Molasses-grass Considered good for tea plantations.

S. procumbens Sw. syn. *S. hamata* Taub. VERANO STYLO

Habit—An annual or perennial, erect to semi-erect, with non-determinate-branching pattern. *Leaf*—trifoliate: leaflets longer than width. *Flower*—small. *Fruit*—pod. *Seed*—medium to dark brown.

Distribution and Ecology—Introduced into India and now grown at CAZRI, Jodhpur (Rajasthan) and Sholapur (Maharashtra). Grows on soils with low fertility; and also on a wide range of soils from shallow sandy clay-loam to black cotton- and red *chalka* soils. Drought-hardy, survives mild frost and tolerates heavy grazing

Cultivation/Regeneration—Fairly good establishment can be obtained by merely broadcasting the seed on uncultivated and unfertilized lands, though good soil-working ensures excellent results. A seed-rate of 4–6 kg/ha is optimum.

Yield—Cultivar 'Verano' gives 15–25 qt dry matter/ha.

UTILIZATION

Reclamation—Suitable for semi-arid tracts of Madhya Pradesh, Gujarat, Rajasthan and Uttar Pradesh, dry lands of Maharashtra, Andhra Pradesh and Karnataka, and dry pockets of Tamil Nadu. Ideal for reclaiming hillslopes, degraded areas and wastelands. Areas with 425 mm rainfall and suitable for establishment.

Fodder—A highly palatable pasture-legume available throughout the year. Suitable to grow with *Cenchrus ciliaris*, *C setigerus* and *Dichanthium annulatum*. Also, performs satisfactorily with *Chloris gayana, Panicum coloratum,* and *Urocloa mosambicensis*.

S. humilis H.B. & K. is a legume for pasture, introduced into India and under trial cultivations at IGFRI, Jhansi. Two **cultivars**, 'IGFRI-S-4109' and 'IGFRI-S-2248' have been found to be very promising for cultivation on wastelands. They produce 410 and 350 qt green fodder/ha in monoculture and 512 and 480 qt/ha with buffelgrass in three years. The seeds contain: protein, 40–45; phosphorus, 0.4–0.8, and sulphur; 0.3–0.5%.

S. scabra Vog. is a perennial pasture-legume, introduced into western Rajasthan, found to be most promising for the semi-arid areas of Madhya Pradesh, Rajasthan, dry lands of Maharashtra, Andhra Pradesh, Karnataka, and dry pockets of Tamil Nadu. Can successfully be grown on degraded soil with low fertility, shallow sandy-clay loam to black cotton- and red *chalka* soils. Forms a thick cover; hence, ideal for hillslopes, wastelands and degraded areas, and succeeds even in areas with rainfall less than 325 mm. Survives mild frost. For easy establishment on uncultivated and unfertilized lands 4–6 kg seed/ha is broadcast, and good soil-working ensures excellent results. Does well with *Cenchrus ciliaris, C. setigerus* and *Dichanthium aunulatum*; also satisfactorily performs with *Chloris gayana, Panicum coloratum* and *Urocloa mosambicensis*. Pure pastures of *S. scabra* have given 40–45 qt fodder/ha after three years.

S. sundaica Taub. syn. *S. mucronata* Miq., non Willd. (TOWNSVILLE LUCERNE) is a decumbent or prostrate annual, introduced at Coimbatore (Tamil Nadu) from South Africa. Excellent pasture-legume, readily grazed by livestock. Can also be used as a cover-crop for tea and coffee and to check soil-erosion.

SUAEDA Forsk. ex Scop. (*Chenopodiaceae*)

Herbs or shrubs; saline and coastal soils; 3 spp in India.

S. fruticosa Forsk. ex J.F. Gmel. SEABLITE

Guj–*Moras;* Hindi & Punjab–*Lunak.*
Delhi–*Lonia;* Rajasthan–*Lunki.*

Habit—A sub-erect or decumbent perennial, 60–120 cm. *Stem*—pale or purplish-tinged, usually slender. *Leaf*—sub-sessile, succulent, very variable. *Flower*—green, turning red with maturity, in leafy spikes, foetid. *Fruit*—turbinate utricle, membranous, spongy. *Seed*—obliquely ovoid, shining, black when ripe.

Distribution and Ecology—Abundantly found in saline tracts and fallow-lands from Punjab eastwards to Uttar Pradesh and southwards to Gujarat and Maharashtra.

UTILIZATION

Reclamation—Recommended for treating waterlogged and highly saline soils. Planted on mounds or ridges to avoid waterlogging. Can be grown in mangrove areas to prevent erosion. Repeated removal of aerial portions of the plant helps in lessening concentration of salt in soil.

Fuel—Dried parts are used.

Fodder—Eaten by camels and goats, though need water; reported to cause black diarrhoea in sheep.

Others—*Leaf:* Aqueous infusion is used as emetic. Poultice applied in opthalmia.

S. maritima Dum. syn. *S. nudiflora* Moq.; *Salsola indica* Willd.

Guj & Mar–*Lana;* Hindi–*Khari lani;* Oriya–*Geria;* Tam–*Uppu keerai;* Tel–*Ilakoora.*

Habit—An annual or perennial, 45–60 cm tall, with numerous, slender, erect branches. *Leaf*—elliptic-oblong or linear obovate, fleshy, often turning red at maturity. *Flower*—in dense, many-flowered clusters, in laxy spikes. *Fruit*—ovoid, utricle, with lenticular, smooth, black shining seed.

UTILIZATION

Reclamation—Suitable for reclamation of saline soils and mangrove areas. Also successfully used for fixing sand along sea-shores. Seed dibbled 3 m apart in wet sand in tidal zone covers the area in a short time. Should be harvested before the leaves drop as the leaves accumulate the salts.

Fodder—Leaf lopped for camels.

Others—*Plant:* used as food (protein, 2.0%) during scarcity.

S. monoica Forsk. ex. J. F. Gmel. (Oriya–*Nunia;* Tam–*Karuvumari;* Tel–*Koyyalakoora*) is a shrubby perennial, *c* 90 cm tall, bearing prominent leafscars, occuring on east and west coasts, also employed for reclamation of saline soils and mangrove areas.

SYZYGIUM Gaertn. (*Myrtaceae*)

Trees or shrubs; tropics of Old World; 75 spp in India.

S. cuminii (Linn.) Skeels syn. *Eugenia jambolana* Lam.; *E. cuminii* Druce BLACKPLUM, JAVA-PLUM

Beng–*Kalajam;* Guj–*Jambu;* Hindi, Mar & Punjab–*Jaman;* Kan–*Nerale;* Mal–*Perinnaral;* Oriya–*Jamo;* Tam–*Neredum;* Tel–*Neereedu.*

Andamans–*Thabye;* Lepcha–*Phoberkung;* Mundari–*Dinkikudadaru.*

Habit—A large, much-branched tree, 30 m/3.6 m. *Stem*—up to 15 m. *Bark*—brown or greyish, fairly smooth, up to 2.5 cm thick, with shallow depressions, exfoliating as woody scales. *Leaf*—shining, lanceolate, elliptic-oblong or broadly ovate-elliptic, 7.5–15.0 cm × 3.8–6.3 cm, coriaceous, gland-dotted, smooth. *Flower*—greenish-white, fragrant, in trichotomous panicles; March–May. *Fruit*—oblong-ovoid, ellipsoid or oblong, up to 2.5 cm long, purplish-black, with pinkish, juicy, 2–5-seeded, fleshy berry; June–August. *Seed*—single, shaped like fruit, 1.2 cm long compressed together resembling a single seed, the whole mass being enclosed in a coriaceous covering; 1200/kg; germination 30 days, 90%; viable for a very short period; fresh seed best.

Several cultivars with different colours and size of fruit, and seedless types have been developed. Var. *axillare* (Gamble) Tenjarla & Kashyapa is found on the western ghats, low hills of Kerala and evergreen forests.

Distribution and Ecology—Found throughout India, up to 1800 m; also commonly cultivated. Grows in a widely different localities, but is generally found in damp places, along streams and swamps where it is often gregarious and grows to a large size. Loamy, deep and well-drained soils are, however, suitable for its optimum growth and development.

Silvicultural Characters—A shade-bearer. Mature tress are drought- and frost-hardy. Remarkable coppicer. Not readily browsed by cattle.

CULTIVATION/REGENERATION

Natural Regeneration—Fruits drop and quickly germinate on moist ground; washed in dense masses during rains, germinate in groups, particularly on alluvial soils; moisture needed for its prolific regeneration.

Artificial Regeneration—Either from direct sowing in August or transplanting the nursery-raised seedlings during July. Care should be taken that moisture is present and to prevent injury to roots, several vegetative methods, such as stumps, hormone-treated cuttings, inarching, grafting and Forket-budding have been found successful. On the roadsides, they are planted 12 m apart and for windbreaks at 6 m. Manuring during prebearing period has been recommended. Several diseases and pests have been recorded attacking all parts including dead wood.

UTILIZATION

Reclamation—Recommended for reclaiming saline, alkaline, wetlands and waterlogged areas, gullies and ravines, and grassy blanks. Also recommended for agro- and social forestry as shade-tree and windbreaks.

Timber—Construction, boat-building, various implements, furniture, sleepers, troughs and teachests.

Fuel—A moderately good fuel (sapwood, 4834 kcal/kg).

Fodder—Leaf (crude protein, 9.1%) palatable for cattle, sheep and goats. *Tasar*-silkworms feed on the leaf. Seed can replace the oilcake in feeds up to 75%.

Others—*Bark:* Yields pectin (6.2%), tannins (10–12%) and a black dye. Used for dyeing and tanning. Astringent; decoction used as mouthwash and gargle and powder in diarrhoea and dysentery. Extract very useful in diabetes. *Leaf:* Yields tannins (6.6%) and essential oil (0.016–0.018%). Used as green manure. *Flower:* A major source of honey in North India and Maharashtra. *Fruit:* Ripe fruits widely eaten (protein, 0.7%). Employed in jelly-, jam-, preserve-, squash- and wine-making. Contains several vitamins and important minerals. Juice of raw fruits is used in vinegar. Astringent. *Seed:* Rich in protein (8.5%) and tannins (19%). Contains an essential oil which possesses antimicrobial properties. Extracts reduce bloodsugar and glycosuria; fresh seed better.

Extracts of bark, stem, leaf, buds and flowers possess moderate antibiotic activity.

TAMARINDUS Linn. (*Caesalpiniaceae*)

Trees; indigenous to tropical Africa and probably also to some parts of South India; represented by *T. indica*, naturalized at many places.

T. indica Linn. THE TAMARIND-TREE

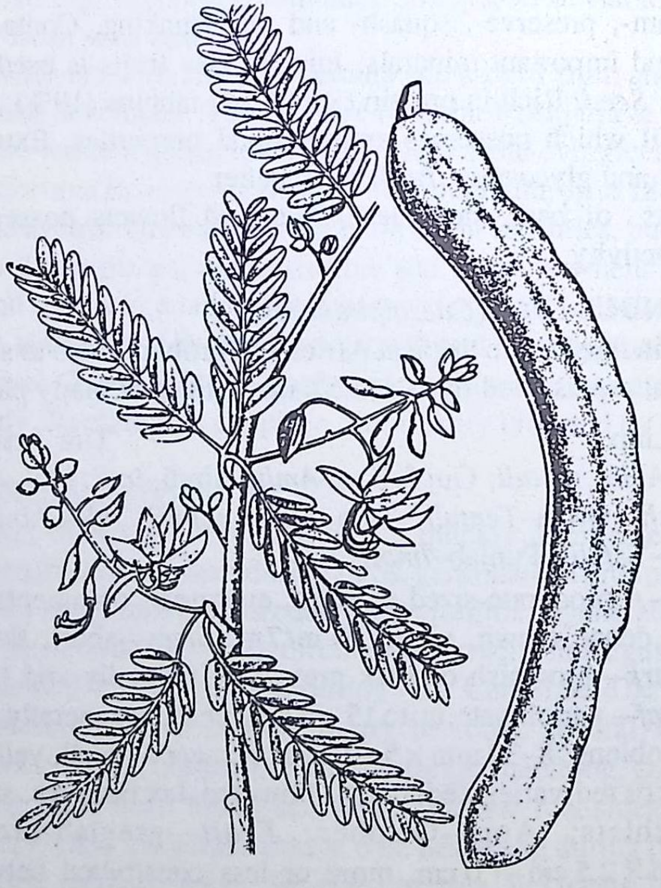
Beng–*Anbli, tentuli;* Guj & Kan–*Amli;* Hindi–*Imli;* Mal–*Amlam, puli;* Mar–*Chinch;* Oriya–*Tentuli;* Tam–*Amilam, puli;* Tel–*Chintachettu.*

Assam–*Tetuli;* Punjab–*Imbli.*

Habit—A moderate-sized to large, evergreen ornamental tree, with handsome, dense crown, up to 24 m/7 m. *Stem*—short, thick, seldom straight. *Bark*—brownish or dark grey, longitudinally and horizontally, fissured. *Leaf*—paripinnate, up to 15 cm long: leaflets generally 10–20 pairs, subsessile, oblong, 8–30 mm × 5–10 mm. *Flower*—small, yellowish, with pink stripes or red-variegated, in few-flowered, lax racemes, at the ends of the branchlets; April–October. *Fruit*—greyish-brown-green, 7.5–20.0 cm × 2.5 cm – 1.0 cm, more or less constricted between seeds, slightly curved, 3–12-seeded pod; ripens from February–April. *Seed*—

obovate-oblong or squarish, compressed, with a shallow, oblong pit on each side of the flat or slightly raised faces, 1.5 × 0.8 cm, smooth, dark brown, shining, contained in loculi, enveloped by a tough, leathery membrane, the so-called endocarp covered with light brownish-red, sweetish-acidic, edible pulp, transversed by several-branched, ligneous stands; outermost covering fragile and easily separable; May–June; 1000–1800/kg; germination 5–20 days, 30–70%; viable for 2 years; needs soaking in cold water for 24–56 hrs, in hot water for 24 hrs.

Distribution and Ecology—Cultivated or found naturalized almost throughout the plains and sub-Himalayan tracts of India, particularly in the South. Largely planted on roadsides. Generally, grows around villages or in deserted villages and thrives only in warmer parts, though grown as far as Punjab. Grows from the coast to the hills. Not exacting as regards the soil, some have naturalized even on rocky land. Young plants grow best on porous soil, sheltered from the sun.



Tamarindus indica

Silvicultural Characters—Withstands drought, but sensitive to frost. Produces rootsuckers. Since no other plant appears under its shade, it is one of the most suitable trees along firelines. Rate of growth slow.

Cultivation/Regeneration—Easy to propagate from seeds and cuttings and budding; propagation through *gootee* recommended for desirable characters. Directly sown in the ploughed lines; for transplanting, seed is sown in April in raised beds having light, porous soils and then transplanted to site during the first rains before the taproot becomes too long. Early growth is fairly rapid than the later growth.

UTILIZATION

Reclamation—Grown for afforestation of the degraded lands in drier areas; also suitable to be grown on alkaline and waterlogged soils, black soils and grassy blanks. Fixes nitrogen. An excellent avenue-tree; recommended for social forestry. Planted for firelines, and for shelterbelts and windbreaks to prevent soil-erosion. Leaves may be tried as green manure.

Host for lac-insect and silkworm.

Timber—Seldom felled for timber. Agricultural implements, tool-handles, wheels, mallets, turnery, printing-blocks, tentpegs; and constructional work. Has been recommended as a substitute for teak and *sal* for beams and rafters.

Fuel—Very good firewood (sapwood, 4909 kcal; heartwood, 4969 kcal/kg). Preferred for making charcoal for gunpowder.

Fodder—Leaves eaten by cattle and goats (crude protein, 13.4%). Ground seed useful as cattle-feed (protein, 17.1–20.1%).

Others—Bark: Yields tannins (7%), a reddish-yellow dye, used for colouring woollen and silk-fabrics, and a gum. Astringent; given in diarrhoea; lotions and poultices are applied to sores and boils. Young bark yields a fibre. *Leaf:* Tender leaves (protein, 5.8%), flowers and the young seedlings eaten as a vegetable; also made into chutney. A good source of calcium, tartaric acid (8–12%) and malic acid, and other important minerals, vitamins and trace-elements. Infusion cooling and useful in bilious fever; poultice applied to swellings and boils, and for relieving pain; extract possesses antibacterial properties; contains essential oil. *Flower:* A source of honey. Poultice applied in inflammatory affections of the conjunctiva. *Fruit:* Eaten raw and ripe. Raw ones converted into pickles and chutneys. Pulp contains proteins (3.1%), minerals, vitamins, tartaric acid (8–18%) and invert sugars (30–40%). Used for souring curries, sauces, chutneys and certain beverages. Pulp used for concentrates. Pulp refrigerant, carminative and laxative and commonly prescribed in febrile diseases and bilious disorders; possesses antiseptic properties; used in dyeing and tanning as an auxillary, and for polishing and cleaning metal ware. *Kernel:* Eaten during famine either alone or mixed with cereal flours, rice or with the flowers of *mahua*. High-grade activated carbon can be prepared from seeds. Powder (tamarid kernel-powder) finds extensive use for sizing the textiles and for gum; serves as a good creaming agent for concentrating rubber-latex, and as a conditioner and stabilizer of soil for brick-making, and as a binder in making sawdust briquettes; can be used as thickner in explosives; suitable for manure. A jellose, an excellent substitute for fruit-pectins, used in confectionary, for sizing and in printing-pastes, and as an adhesives, can be prepared. Yields an oil (6.0–7.4%) resembling groundnut oil; may be useful in paints and varnishes and for illuminating. *Testa:* Used in dyeing and tanning and in plywood adhesives. Astringent; used in diarrhoea and dysentery.

TAMARIX Linn. (*Tamaricaceae*)

Graceful shrubs or trees; temperate regions of Europe and Asia; 5 spp in India.

Tamarix spp, commonly known as TAMARISK, prefer alluvial soil, but grow well on saline and alkaline soils also. Excellent windbreaks on sea-coasts, can thrive in saltspray, and useful in arresting soil-erosion. They are also cultivated for ornament. Several species have medicinal properties or yield a dyestuff and a useful wood.

T. aphylla (Linn.) Karst. syn. *T. articulata* Vahl

Beng–*Rakta-jhav;* Guj–*Lal-jhav-nu-jhade;* Hindi–*Lal-jhav;* Tam–*Shivaptu-atru-shavukku;* Tel–*Erraerusaru.*

Punjab–*Farash.*

Habit—A moderate-sized, rapid-growing tree, up to 18 m. *Stem*—erect, with tapering trunk having branches, often hoary with a saline efflorescence. *Bark*—rough, grey. *Leaf*—sheathing, free portion consisting of a minute, triangular tooth. *Flower*—pink, scattered on long, slender spikes, borne in loose panicles. *Fruit*—trigonous capsule, rounded at the tip. *Seed*—small, with a tuft of long hairs; 286,500/kg; October.

Distribution and Ecology—Found in Punjab, Haryana, Rajasthan, Uttar Pradesh, and Gujarat. Often grown for ornament. A halophyte, grows on saline soils with good drainage and deep sandy and alluvial soils. Also found in arid regions with extremes of temperatures and excessive drought; also withstands inundation. Tolerates high degree of alkalinity.

Silvicultural Characters—Withstands drought and to a certain extent frost. Freely coppices. Needs little attention.

Cultivation/Regeneration—Can be propagated from seed by sowing in January. Seedlings can be transplanted by the end of June, when 7–10 cm high with the onset of monsoon. Also propagated from cuttings by putting them in moist sand in March and planting them in August. Requires little water once it strikes roots.

UTILIZATION

Reclamation—Useful as a good soil-binder. Recommended for reclaiming shifting sands and stabilizing sand-dunes, highly saline and alkaline, waterlogged and semi-arid soils, mangrove areas, saline beaches of the coastal alluvium; tolerates arsenic concentrates and can be grown on such minespoils. Recommended as a windbreak for orchards, roadside plantation; and is a promising hedge.

Timber—Ploughs, Persian wheels, cots, carts, turnery, house-building; suitable for particle-boards.

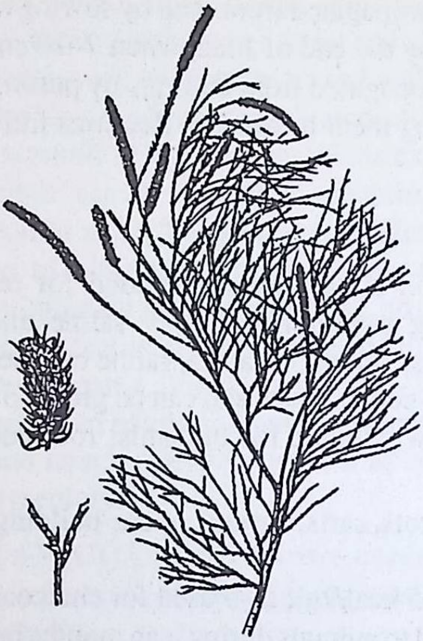
Fuel—A cheap fuel (sapwood, 4835 kcal/kg); also used for charcoal.

Fodder—Green leaves and fruits fed to animals during lean months but with more water.

Others—*Bark:* Bark and gall (Hindi–*Choti-mayin;* Bombay–*Magiya-main*) yield tannins (up to 50%), used in fine-grade leather-tanning and as a mordant in dyeing. Galls can be substituted for oak-gall and sumac. Bitter and astringent; employed in eczema. Gall very astringent; used for gargling. *Twig:* Made into basket.

T. dioica Roxb. (Beng, Guj, Hindi & Assam–*Jhau;* Tel–*Palivela:* Ladakh & Kashmir–*Rgelta;* Punjab & Rajasthan–*Pilchi*) is a gregarious shrub or small tree, up to 2 m, having obliquely truncate leaves, pink or purple flowers, in dense, peduncled spikes and oblong or conical capsules, found throughout India. Grows on riverbeds and near coasts and in mangroves, and also in Rajasthan desert, on graded riverbeds; may be grown for reclaiming such areas. Yields moderately good fuel; twigs pliated into baskets. Several parts yield tannins: galls, 50%; leaf, 8%; twigbark, 10%; and bark, 8%.

T. ericoides Rottl. (Hindi–*Jhau*) is a handsome shrub, with minute, scale-like, ovate-lanceolate leaves and pink flowers, chiefly found in the riverbeds in South India, extending northwards into Chota Nagpur, and sand-dunes of Rajasthan. Can be grown for stabilizing the sand. Cooked with rice, leaf is given to children to relieve cough. Twig used for making brooms and brushes. Also used for firewood. Young branch contains tannins (10.2%); leaf, 3.7%; and inflorescence, 16.2%.



Tamarix dioica

T. ericoides

T. troupii Hole syn. *T. gallica* auct.; Dyer (Fl Br Ind) in part, non Linn. (Beng, Hindi & Mar–*Jhav;* Guj–*Jhav-nu-khada;* Oriya–*Jaula*) is a gregarious, fast-growing, bushy shrub, with minute leaves, pink or white flowers, found in North India on sandy or gravelly areas and low-lying saline, waterlogged soils and on riverbanks, and such soils can be reclaimed. A strong light-demander; withstands drought and ordinary frost. Vigorously coppices and flourishes even with scanty rainfall. Easily propagated from seed, cutting and stool-shoot. Recommended for afforestation in Ladakh. Timber useful for firewood, agricultural implements, turnery and lacquer-work. Twig employed for thatching. Gall (tannins, 45%) astringent and useful in treating ulcers, piles and fissures, sore throat, diarrhoea and dysentery; useful for chrome-tanning. Extract used in medicinal preparations for anxiety neurosis, fatigue, liver disorders, *senile pruritus*, etc.

TECOMELLA Seem. (*Bignoniaceae*)

Woody climbers, shrubs and trees; tropics; 5 spp in India.

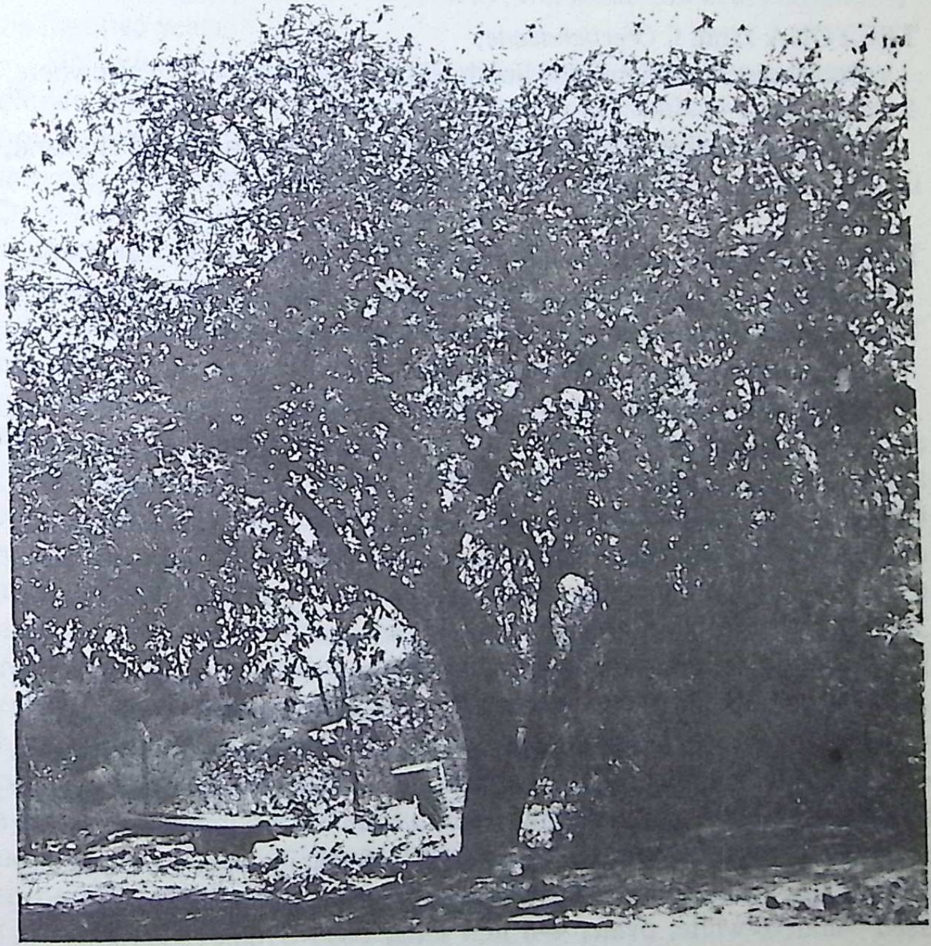
T. undulata (Sm.) Seem. syn. *Tecoma undulata* G. Don; *Bignonia undulata* Sm. ROHIDA-TREE

Hindi–*Rugtrora;* Mar–*Rakhtreora.*

Bombay, Punjab & Rajasthan–*Roira.*

Habit—A deciduous or nearly evergreen, ornamental shrub or a small tree, up to 12 m/2.4 m. *Leaf*—grey, oblong or linear-oblong. *Flower*—pale yellow to deep orange in few-flowered, corymbose racemes; January–April. *Fruit*—slightly curved, smooth capsule, 15–20 cm long; May–July. *Seed*—winged; 70,240/kg; March; germination 0–30%.

Distribution and Ecology—Drier parts of North-West and western India from Punjab to Maharashtra, extending eastwards up to the river Yamuna, up to 1200 m in the outer Himalayas. Also grown for ornament. Grows in arid regions with 25–400 mm rainfall and found in small patches. Found growing on sandy, well-drained, fibrous loam, older alluvium in arid zone, loamy sand, deep sandy and mineral soils. Drought-hardy and very resistant to fire, and low in salt-tolerance.



Tecomella undulata

Cultivation/Regeneration—Propagated from seed and cutting.

UTILIZATION

Reclamation—Commonly used for afforestation and landscaping of dry arid, semi-arid tracts and sand-dunes. Grown for its handsome deep-orange flowers in parks and compounds and planted along the roadsides. In Rajasthan, planted as windbreak and hedge; suitable to grow as shelterbelts in controlling sand-drift areas.

Timber—Furniture, carvings and agricultural implements.

Fodder—Leaves readily eaten by cattle (crude protein, 10.15%); rich in calcium.

Others—Bark: Used for tanning. Useful in liver complaints, cancer and swellings. Stem-extract possesses antibacterial properties.

TECTONA Linn. f. (*Verbenaceae*)

Deciduous trees; South and South-East Asia and introduced elsewhere; 1 sp in India.

T.grandis, indigenous to India, Burma and the western parts of Thailand, is the source of TEAKWOOD.

T. grandis Linn. f. THE TEAK

Beng–*Segun;* Hindi & Mar–*Sagwan;* Guj–*Saga;* Kan–*Tega;* Mal & Tam–*Thekku;* Oriya–*Singuru;* Tel–*Adaviteeku, peddateeku.*

Assam–*Chingjagu;* Lepcha–*Ripnyok.*

Habit—A quick-growing tree, with rounded crown, very variable in size, with straight stem, up to 27 m / 7 m. *Stem*—in favourable localities attains a large size, with tall, clean, cylindrical bole, having uniform girth, becomes fluted and buttressed with age. *Branchlet*—characterstically quadrangular, channelled. *Bark*—fibrous, light brown or grey, 4–18mm thick, exfoliating in long, thin strips. *Leaf*—broadly elliptical or obovate, 30–60 cm × 20–30 cm, gradually becoming smaller, finally becoming bract-like in inflorescence, often larger in coppice-shoots, coriaceous, rough above, stellately-tomentose beneath, possessing minute, red, glandular dots which turn black. *Flower*—small, white, sweet-scented, numerous, in 45–90 mm long, conspicuous, terminal panicles; June–September, under abnormally wet conditions from April. *Fruit*—hard, long, irregularly globose, somewhat pointed at the apex, 10–15 mm in diam, enveloped by light-brown, bladder-like calyx, 1–3- or rarely 4-seeded; November–January. *Seed*—marble-white, ovate, 4–8 mm long, 2000–3100/kg; germination 15days onward, 60–80%; dormant for about a year but more in seeds from dry localities; stores well for 2–3 years at room temperature; needs pretreatment of wetting and drying.

Distribution and Ecology—Indigenous to peninsular India and Madhya Pradesh, extending into parts of Rajasthan, southern Uttar Pradesh and Orissa. Outside its natural habitat, teak has been planted in the forests, parks and gardens of Uttar Pradesh, West Bengal, Assam, Bihar, Orissa and the Andamans. Thrives best and reaches the largest size in a fairly moist, warm, tropical climate and rich soils, although occurs even in dry localities subjected to great heat and drought. Generally found on the undulating country; also found on alluvial sandstones, deep, moist, sandy, fertile loams and needs well-drained soils. Avoids lateritic and waterlogged soils and ravines in Gujarat. Recently reported from Shrirampur in Maharashtra that the teak is being grown in low, dry, rocky, arid wasteland with irrigation in the first two years.

Silvicultural Characters—A pronounced light-demander and does not tolerate suppression. Sensitive to competition, particularly roots. Resists drought but sensitive to frost. Coppices and pollards vigorously. It is not browsed, withstands injuries from cutting and fire.

CULTIVATION/REGENERATION

Natural Regeneration—Takes places from seed, but the extent depends upon the climatic and edaphic factors. Seed is dispersed through water in quantity on alluvial flats and germinates. Baking and soaking also stimulate; fire may also stimulate the seed lying on the ground; seedlings need protection from grazing and fire. Also, occurs in certain plantations raised outside the zone of teak.

Artificial Regeneration—Directly broadcast or dibbled, or nursery-raised seedlings transplanted in April; the latter is preferred. Seed is sown in well-prepared raised beds in moist areas or sunken beds in dry areas during March–June, depending upon the locality. Rate of seed for each bed of 12 m × 1.2 m varies from 5 to 12 kg depending upon the locality. Seeds are covered and mulched, and watered in dry areas. Watering is slowly reduced. Stumps from seedlings of 1–2 cm thick are prepared with 1.5–5.0 cm shoot and 15–25 cm taproot without lateral roots and planted during rains; split-halves also give satisfactory results. Sprouted stumps raised in April in polythene-tubes give better results. Site is prepared by burning the slash and,with good rainfall of 150 cm, 2.6 m × 2.6 m is suitable. Depending upon moisture, the stumps are planted in crowbar holes or 30 cm^3 pits. NPK (1:2:4) is also given in latertic soils.

UTILIZATION

Reclamation—Recommended for deep and narrow gullies and ravines, lignite spoils, island-regions and semi-moist areas and for control of erosion; recommended for and grown under agro- and social forestry. Agricultural crops, which do not have an adverse effect on teak, such as maize, hillpaddy, chillies, horsegram, *ragi*, etc., can be cultivated for 1–2 years in between teak. Also grown for shelterbelts, windbreaks and as hedge.

Rainfall is reported to increase, and watertable is reported to improve besides environment.

Timber—One of the most important hardwoods the world over. Poles, piles, ship-building, all types of construction, bridge-building, coach-building, railways, frames, panelling, houses, various grades of plywood, particle-boards, fire-boards, furniture, cabinet-making, lorry-bodies, carts, carriages, mathematical instruments, violin-keys, long neck of sitar and body of harmonium, agricultural implements; chipboards of satisfactory strength and paper for writing and printing can be made from the waste wood-shavings. Activated charcoal can be made from sawdust. Timber yields an oily product (0.15%); used for eczema, ringworm, and as antimaggot in sores of cattle; sawdust also allays inflammation of skin. Extract of trunkbark and woodchips possesses anti-ulcer properties.

Fuel—Good firewood, but not used (sapwood, 4989 kcal; heartwood, 5535 kcal/kg). Charcoal can also be made.

Others—Bark: Contains appreciable amount of oxalic acid (8.3–15.5%). *Leaf:* Yields a yellow or red dye suitable for dyeing silk and wool yellow, olive or related shades; also yields tannins (6%). Plastic- and particle-boards of satisfactory strength can be made. Used for polishing jackwood. Extract inhibits tuberculosis bacterium. *Flower:* Useful in biliousness, bronchitis and urinary discharges. *Seed:* Yields a fatty oil (2%), and promotes hair-growth; extract used as a lotion for eye-troubles.

TEPHROSIA Pers. (*Fabaceae*)

Herbs or subshrubs, or rarely shrubs; tropics and subtropics; 35 spp in India.

Tephrosia spp are grown for soil-conservation, green manure and ornament, and as covercrops. Several species have insecticidal and piscicidal properties and many parts contain rotenoids. Some fix nitrogen.

T. candida DC. WHITE TEPHROSIA

Beng–*Bangara;* Guj–*Dholo sarpankho;* Hindi–*Masethi;* Tel–*Tellavempali.*

Assam–*Boga medaloa;* Cachar–*Mith-phang;* Garo–*Samendu;* Khasi–*Dieng-toh.*

Habit—A gregarious shrub, 1.2–4.5 m. *Stem*—slender, sometimes woody, branches with persistent, brown or grey, velvety pubscence. *Leaf*—imparipinnate, 12–25 cm long: leaflets 15–25, narrowly oblong to obovate-oblong, 3.8–5.2 cm, grey or white, silky beneath. *Flower*—creamy white, tinged with red, in racemes. *Fruit*—slightly recurved, clothed with brown, silky hair, 10–15-seeded pod,7–10 cm long. *Seed*—brownish; 3-month-old seed needs pretreatment with sulphuric acid and hot water.

Distribution and Ecology—Tropical Himalayas from Kumaun to Bhutan and in Assam and other parts of eastern India, up to 1700 m; recorded from Chota Nagpur and Gujarat; introduced into the tea and coffee plantations in the peninsular India. Occasionally grown for ornament and in avenues.

Silvicultural Characters—Tolerates light shade. Withstands drought, waterlogging and pruning. Not relished by cattle.

Cultivation/Regeneration—Pretreated seed may be dibbled in rows 60–90 cm apart during monsoon; or sown earlier, if irrigation available. Plants ready for pruning after 6 months. Crop survives for over 5 years if periodically pruned. From second year onward 3–4 cuttings can be obtained, maximum being during the rainy season; 4.5–7.8 kg green matter can be obtained per pruning. Susceptible to many diseases and pests.

UTILIZATION

Reclamation—Useful for soil-conservation in southern and eastern region; improves soil and covers and reclaims it. Grown for shelterbelts, windbreaks and as hedge; also grown for nursing and mulching the tea, coconut, coffee, rubber and *sal*. One of the best green manures, particularly on poor soils. Fixes nitrogen. Plant poisonous to fish.

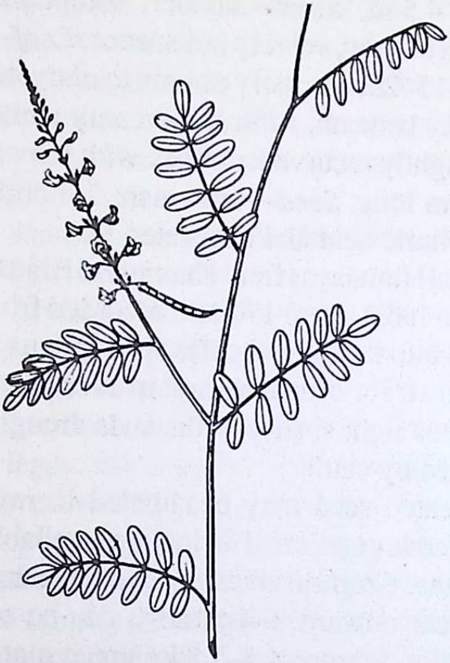
Others—Seed: Contains an oil (9.8%).

T. purpurea (Linn.) Pers.; Baker (Fl Br Ind) in part WILD INDIGO

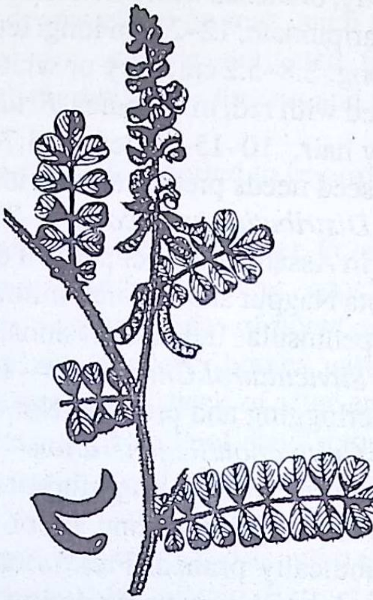
Beng–*Ban-nil-gachh;* Guj–*Ghodakan;* Hindi–*Dhamnasia;* Kan–*Empali;* Mal–*Kozhenjil, kaataneiri;* Mar–*Sirapakha;* Oriya–*Kolothiyapokha, soropokha;* Sans–*Sharapunkha;* Tam–*Kolingi, katkoungi;* Tel–*Vempali, neelavempali, bontavempali.*

Delhi–*Jhojhru, jangli-mothar;* Mundari–*Bircakonda;* Punjab–*Bansa-bansu, jhojhru.*

Habit—A polymorphic, much-branched, suberect, hardy, perennial herb, 30–60 cm. *Leaf*—imparipinnate, 5–15 cm long: leaflets 9–21, narrow, oblanceolate, glabrous above, obscurely silky below. *Flower*—red or purple in leaf-opposed racemes. *Pod*—slightly recurved, 3.7–5.0 cm × 4.0 mm, glabrescent, 5–10-seeded. *Seed*—greenish-grey, smooth; needs pretreatment with hot water or scarification or both.



Tephrosia purpurea



T. villosa

Distribution and Ecology—Throughout India, up to 1850 m in Himalayas. Found in arid areas, Rajasthan desert-hills and rocky outcrops, lower and eroded rocky surfaces and flat-exposed piedmont plains. Grows on light sandy or deep sandy or loamy soils, rocky areas and old alluvial sandy soils of Rajasthan.

Cultivation/Regeneration—Pretreated seed (22–44kg/ha) is directly sown; if grown for 3–4 years, generally regenerates from the self-sown plants. For green manure, the plants are ploughed *in situ.*

UTILIZATION

Reclamation—Best suited to light-sandy or loamy soils, although it can also be grown on rocky areas. Commonly cultivated as a green manure for paddy, coconut and banana in South India; also grown in tobacco and rubber plantations elsewhere. Fixes nitrogen.

Fodder—Leaf used as fooder (crude protein, 24.43%).

Others—Herb: Dried herb considered hypnotic, tonic, laxative, diuretic and deobstruent; used for bronchitis, bilious febrile attacks, boils, pimples and bleeding-piles, liver and kidney disorders. *Leaf:* Yields a dye. Useful in jaundice. *Root:* Decoction given in dyspepsia, diarrhoea, rheumatism, asthma and urinary disorder. *Rootbark:* piscicidal. *Seed:* Yields an oil, used for eczema. Substituted for coffee. Extract possesses antidiabetic properties.

T. hookeriana Wight & Arn.; Baker (Fl Br Ind) in part, is a small shrub, found in Tamil Nadu, Karnataka, Kerala, Rajasthan and Madhya Pradesh, up to 900 m; recommended as a cover-crop and for green manure.*T. maxima* Pers., non Baker syn. *T. purpurea* Baker var. *maxima* Baker (Fl Br Ind) is an undershrub, found in Orissa, Andhra Pradesh, Karnataka and Kerala, especially on coast. Used as green manure; and for shade for tea and coffee in Indonesia.*T. noctiflora* Bojer ex Baker syn. *T. hookeriana* Baker (Fl Br Ind) in part, non Wight & Arn.; *T. subamoena* Prain (Tam–*Sermaikolingi*) is a woody, perennial herb or shrub, up to 2.1 m, introduced into South India, West Bengal and Jammu. Can be grown as green manure. Highly drought-resistant and capable of withstanding water-logging. Seed contains oil (9%). *T. procumbens* Buch.-Ham. syn. *T. purpurea* (Linn.) Pers.; Baker (Fl Br Ind) in part var. *pumila* Baker is a deep-rooted herb, found from Jammu & Kashmir, Punjab and Rajasthan to West Bengal, extending into peninsular India. Recommended for cultivation. *T. singapou* (Buchoz) Cheval. syn. *T. toxicaria* Pers., introduced into Jammu, cultivated as green manure and cover-crop elsewhere. Possesses piscicidal and insecticidal properties. *T. tinctoria* Pers.; Baker (Fl Br Ind) in part (Kan–*Silagida*) is a pretty undershrub, covered with golden-brown pubescence, and pale-red, silky flowers, found in peninsular India and Bihar, up to 2100 m. Forms an excellent cover for tea and coffee. Recommended for pastures, green-manuring. Yields a dye. *T. villosa* Pers.; Baker (Fl Br Ind) in part (Guj–*Runchhalisarpankho;* Oriya–*Sroetokolothiya;* Tam–*Vaykkavalai;* Tel–*Nooguvempali*) is a much-branched, densely clothed herb, up to 90 cm, found in Punjab, Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh, Bihar and West Bengal. A drought-resistant plant, not grazed by cattle, reported to be a good green manure. Root contains rotenone, an effective insecticide. Fixes nitrogen. *T. vogelii* Hook. f. (Fishpoison Bean) is a much-branched subshrub, up to 4 m, native to tropical Africa, introduced into Assam and South India as a covercrop cultivated as windbreak and for green manure. All parts are toxic to fish and molluscs; also possess insecticidal properties. Fixes nitrogen.

TERMINALIA Linn. (*Combretaceae*)

Mostly deciduous trees and rarely woody climbers; tropical Asia, Africa and America; 16 spp in India.

Timber of many species is important; bark yields tannins; kernel of few are edible.

T. alata Heyne ex Roth syn. *T. tomentosa* Wight & Arn.

Beng–*Asan;* Guj–*Sadar;* Hindi–*Asan, sain, saj;* Kan–*Sadada;* Mar–*Ain;* Oriya–*Sahaju;* Tam–*Karramarda;* Tel–*Nallamaddi.*

TRADE–*Laurel.*

Habit—A large, deciduous, straight-stemmed tree, with wavy crown, 32 m or more. *Stem*—clean, straight bole, up to 21 m/5.6 m in favourable localities. *Bark*—grey to black, with deep, longitudinal fissures and transverse cracks. *Leaf*—elliptic or ovate, with 1 to 2 glands near the base. *Flower*—dull yellow, in terminal and axillary panicles; May–July, depending upon the locality. *Fruit*—up to 5cm long, with 5 broad, coriaceous horizontally veined wings; 400–700/kg; February–May. *Seed*—13 000/kg; germination 4–70 days, 35–70%; viable up to 12 months; needs soaking in water.

Distribution and Ecology—From Himachal Pradesh to Assam, extending into the peninsular India, up to 1200m. Found in tropical moist and dry, deciduous forests. Attains large dimension on deep, rich, alluvial soil. On poor and shallow soil, particularly on hilly ground, though often plentiful, remains stunted. Gregarious in depressions and by roadsides and the edges of swamps.

Silvicultural Characters—A light-demander and does not tolerate shade. Seedlings fairly drought-hardy, but sensitive to frost; as it matures, resists frost. Fairly tolerant to fire. Possesses deep rootsystem, sometimes producing suckers when roots are exposed. Coppices and pollards well. Needs two weedings in first two years, and protection from browsing by deer and pigs; parrots also destroy the fruits.

CULTIVATION/REGENERATION

Natural Regeneration—Establishes well from seed and coppice-shoots.

Artificial Regeneration—Directly sown or transplanted in the prepared soil in the rains. Stumps of 2 cm from one-year-old seedlings after the first showers in April are best to regenerate the areas likely to be waterlogged; also root- and shoot-cuttings employed. For transplanting, seed is dibbled at 7.5 cm × 8.5 cm in raised, shaded beds; regularly watered and weeded; seedlings ready for transplanting early during the rainy season. A few fungi and defoliators have been recorded.

UTILIZATION

Reclamation—Recommended for reclamation of waterlogged areas and for social forestry.

Timber—Buildings, joints, poles, beams, rafter, tool-handles, marine construction, veneers, plywood, boards, etc. Suitable for use in fireproof buildings.

Fuel—Very good firewood (sapwood, 5047 kcal; heartwood, 5373 kcal/kg).

Fodder—Leaf (crude protein, 12.72%) lopped for cattle; and for feeding *tasar*-silkworms.

Others—Bark: Yields tannins (18.7%); useful in tanning leather as a substitute for *babul*, and for dyeing cotton, silk, wool, jute, and pulp and paper. Useful for extraction of oxalic acid. Astringent; given in diarrhoea and ulcers. Exudes a gum; used as purgative and adhesive.

T. arjuna (Roxb.) Wight & Arn.

Beng–*Arjhan;* Guj–*Sadado;* Hindi & Punjab–*Arjuna;* Kan–*Maddi;* Mar–*Sadaru, vellamarda;* Oriya–*Arjuno, sahajo;* Tam–*Vellamatta;* Tel–*Yerramaddi.*

Assam–*Orjun;* TRADE–*Arjun.*

Habit—A large, evergreen, tree, with a spreading crown and drooping branches, commonly 3m in girth, but recorded up to 10.6 m. *Bark*—very thick, grey or pinkish-green, smooth, exfoliating in thin,irregular sheets. *Stem*—rarely long and straight, buttressed, sometimes fluted. *Leaf*—subopposite, oblong or elliptic, coriaceous, usually 10–15 cm × 2 cm. *Flower*—white, small,in panicled spikes; April–July. *Fruit*—ovoid or ovoid-oblong, 5–7-seeded, 2.5–5.0 cm long, with winged angles. *Seed*—hard, 775–800/kg; germination 50–76 days, 50–60%; needs soaking in water.

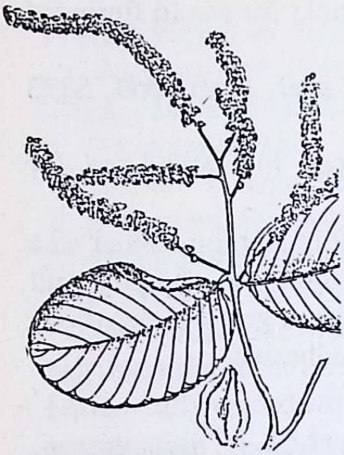
Distribution and Ecology—Common in most parts of India; extensively planted in many parts for shade and ornament. Grows well along banks of streams, rivers, ravines, dry watercourses, reaching very large sizes on fertile alluvial loam.

Silvicultural Characters—A moderate shade-bearer, but does not tolerate dense overhead shade. Seedlings sensitive to drip, drought and frost, but grows well if moisture is available. Produces rootsuckers. Coppicing is satisfactory and pollards very well. Not suitable for open, dry hillsides.

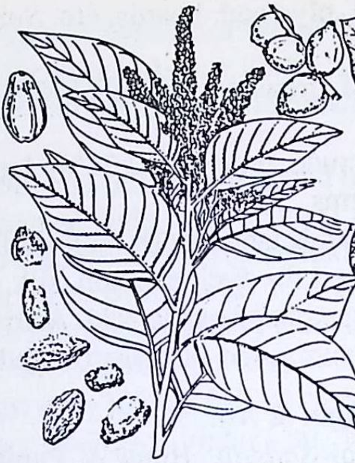
CULTIVATION/REGENERATION

Natural Regeneration—Generally satisfactory. Dense patches are often seen on alluvial soils. If moisture is available in the soil, regeneration takes place.

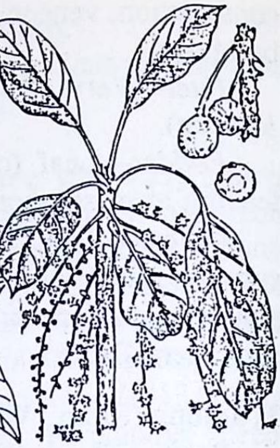
Artificial Regeneration—Can be raised through direct-sowing of seed, entire transplants, stumps, or air-layers.



Terminalia alata



T. chebula



T. bellirica

UTILIZATION

Reclamation—Recommended for reclamation of saline, alkaline and semi-arid tracts and ravines. Also recommended for agro- and social forestry.

Timber—Carts, agricultural implements, watertroughs, traps, boat-building, house-building, electric poles, tool-handles, jetty-piles, and plywood.

Fuel—Used as firewood.

Fodder—Leaf suitable for sheep (crude protein, 10.94%). Given to *tasar*-silkworms.

Others—Bark: Used for tanning (22–24%). Considered an excellent stomachic, antidysenteric, cardiac tonic, diuretic, styptic, and endocarditis; also useful in liver disorder, spermatorrhoea, gonorrhoea and phthisis. An ingredient of GERIFORTE, given in *senile pruritus*, fatigue and anxiety neurosis. Extracts possess hypotensive and bradycardiac activities. *Leaf:* Yields tannins (11.12%); used in ulcers. *Fruit:* Yields tannins (7–20%); tonic, deobstruent.

T. bellirica Roxb. BELLIRIC MYROBALAN

Beng–*Bhairah;* Hindi–*Bahera;* Mal & Tam–*Tani;* Mar–*Beheda;* Oriya–*Bhara;* Tel–*Thandrakaaya* (fruit).

TRADE–*Belliric Myrobalan.*

Habit—A handsome tree, up to 40 m/1.8–3.0 m. *Leaf*—broadly, elliptic, clustered towards the ends of branches. *Stem*—straight, frequently buttressed when large, clear bole of 6–9 m. *Bark*—bluish or ash-grey, with numerous, fine, longitudinal cracks, yellow inside. *Flower*—greenish-white, with honey-like smell, in axillary, simple ovoid, pyriform or ellipsoidal spikes; April–May. *Fruit*—globular, obscurely-5-angled, somewhat fleshy drupe, 1.3–2.0 cm diam, grey, velvety, tomentose; 176–420/kg; November–February; germination 14–30 days, 38–100%; viable for 1 year; needs alternate soaking and drying.

Distribution and Ecology—Throughout the greater part of India, but not in arid region. Found in deciduous forests and moist valleys; common associate of *sal*, teak, etc. Grows well in moist situations, and on saline and alkaline lands.

Silvicultural Characters—A light-demander, though can tolerate light shade when young. Fairly withstands drought but sensitive to frost. Coppices fairly well.

CULTIVATION/REGENERATION

Natural Regeneration—Seed is widely dispersed and adequate regeneration can be seen in moist forests.

Artificial Regeneration—Can be raised from direct sowing or by transplanting the entire, one-year-old, nursery-raised seedlings sown during March–May; seedlings ready for transplanting in July. Stump-plants also can be employed.

UTILIZATION

Reclamation—Can be grown on saline and alkaline soils; recommended for social forestry.

Timber—Shafts, rafters, boards, carts, pit-props, house-buildings, boats, boxes, heavy-packing, etc.

Fuel—Good for firewood (sapwood, 4972 kcal/kg); also used for charcoal.

Fodder—Leaf (crude protein, 15.06%) given to *tasar*-silkworms. Fresh fruits and kernel greedily eaten by animals.

Others—Bark: Yields tannins (1.4–7.0%) and gum. Mildly diuretic. *Leaf:* Contains tannins (6.42%). *Fruit:* Called BELLIRIC MYROBALAN, used for tanning sole- and garment-leathers (tannins, 25%). Astringent; used in dropsy, piles diarrhoea; possesses cardiac-depressant, hypotensive, choleretic, antitussive, antiasthmatic, anthelmintic and purgative properties. Used as an ingredient in ayurvedic formulations for viral hepatitis, gastrointestinal disorders, vitiligo, etc. Extracts are antibacterial and antispermicidal. Oxalic acid can be extracted. *Kernel:* Yields a non-edible oil (38.6%), used for soap manufacture. Narcotic, and given in dyspepsia. Protein can be used for adhesives.

T. catappa Linn. THE INDIAN ALMOND-TREE

Beng–*Bangla-badam;* Hindi–*Deshi-badam;* Mal–*Adamarram;* Tam–*Natvadom;* Tel–*Baadamuchettu, vedam.*

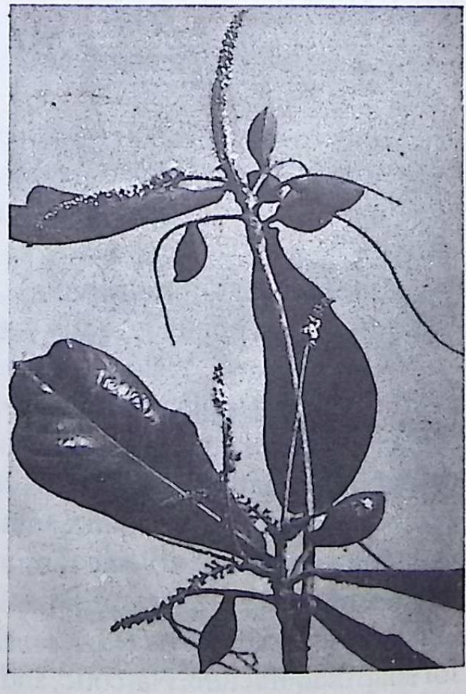
Andamans–*White Bombway*; TRADE–*Indian Almond-wood.*

Habit—A very fast-growing, large, handsome tree, 18–30 m. *Branch*—whorled, monochasial, giving a characteristic appearance. *Stem*—often buttressed, clear bole 12 m. *Bark*—not very smooth, brownish-grey or dark grey. *Leaf*—large, obovate, glabrous above, pubescent beneath, obovate, often turns red before falling; crowded at the tip of branches. *Flower*—white, small, star-shaped, in axilllary spikes; February–May; October–November. *Fruit*—yellowish or reddish, ellipsoidal, distinctly compressed drupe, 3.5–5.0 cm long, with fleshy pericarp. *Seed*—edible, oily, almond-like in taste; 176/kg; June–July; germination 25%.

Distribution and Ecology—Common in the Andamans and also in coastal and interior of Andhra Pradesh. Extensively cultivated in gardens of tropical India for ornament and fruit. Found on black cotton-, murrumy and sandy and shingly, and saline soils. Often growing near beaches; also grows on alluvial deposits, formed of detritus. Found in moist tropical climate. Essentially a littoral species growing on beaches and sandy soils.

Silvicultural Characters—Generally a light-demander but tolerates

T. arjuna



T. catappa

shade. Fairly drought-resistant but generally not frost-resistant. Branches brittle.

CULTIVATION/REGENERATION

Natural Regeneration—Easily grows from seeds. On loose soils the fruits germinate and the seedlings establish readily.

Artificial Regeneration—Can easily be raised from the seed, either from direct sowing or entire planting in the rains. Freshly collected fruit is sown in nursery in July and transplanted in South-West monsoonal rains. Subjected to attack by some fungi and insects.

UTILIZATION

Reclamation—Tolerates salt and recommended for saline and alkaline soils. Mainly planted for shade and ornament. Recommended for social forestry.

Timber—House-building, general carpentry work; and pulp.

Fodder—Leaf fed to *tasar*- and *katkura*-silkworms. Kernel cake can be given as feed to animals.

Others—Bark: Yields tannins (9–13%); also a dye used for dyeing silk, cotton and wool. Astringent. *Leaf:* Yields a dye; used for dyeing silk and wool. Juice applied to cutaneous diseases. Woven into platters on commercial scale. *Fruit:* Ripe pericarp acid sweet and eaten by humans and birds. Contains a red dye. *Shell:* Source of furfural. *Kernel:* Eaten like almonds. Yields an oil (32–58%); can be a substituted for the oil of almonds.

T.chebula Retz.; C.B. Clarke (Fl Br Ind) in part CHEBULIC MYROBALAN

Beng–*Haritaki;* Guj–*Hardo;* Hindi–*Harra;* Mar–*Hirda;* Oriya–*Haridra;* Tam–*Kadukkai;* Tel–*Karakkaaya.*

Assam–*Silikha;* Punjab–*Har.*

TRADE–*Chebulic Myrobalan; myrobalan.*

Habit—A tree, with a round crown and spreading branches 15–24 m/ 1.5–2.4 m. *Bark*— dark-brown, often longitudinally cracked, exfoliating in woody scales. *Stem*—cylindric, bole 4–9 m. *Leaf*—ovate or elliptic with a pair of large glands at the top of petiole. *Flower*—yellowish-white or greenish-white, in terminal spikes; March–August; depends upon places: March–May or June in the hills, sometimes also occurs during July–August. *Fruit*—ellipsoidal, obovoid or ovoid, yellow to orange-brown, sometimes tinged with red or black and hard drupe when ripe, 3–5 cm long, becomes 5-ribbed on drying; 140–220/kg. *Seed*—hard, pale yellow; November–March; germination 15–90 days, 60%; viable up to 12 months;

needs pretreatment; fermentation gives best germination or cutting the end of embryo without damaging and soaking for 36 hrs; also alternate wetting and drying helps.

Distribution and Ecology—Throughout the greater part of India up to 1500m. Grows to large sizes in deciduous and moist forests in rocky and dry places in the outer Himalayas; and on the hills of Deccan and South India, it is smaller. Found growing on a variety of geological formations; grows on clayey and also on sandy soils and in the *babhar* tract.

Silvicultural Characters—A strong light-demander; cannot tolerate shade or cramped situation. Drought- and frost-hardy to a considerable extent; withstands fire well and has remarkable power of recovery. Coppices well, and these shoots are often vigorous.

CULTIVATION/REGENERATION

Natural Regeneration—Good in some localities and absent in others. Intensive collection of seed may be responsible, besides destruction of seed by animals. For regeneration, good drainage is essential; possibly side-shade desirable. Manipulation of canopy facilitates regeneration.

Artificial Regeneration—Can directly be sown and also transplanted. Pretreated fruit is sown in nursery and transplanting of one-year-old seedlings is more successful. Young plants may require watering during the first hot-weather.

UTILIZATION

Reclamation—Very suitable for windbreaks and shelterbelts.

Timber—Construction, agricultural implements, posts, beams, packing-cases, teachests, and slateframes.

Fuel—A poor firewood (3967 kcal/kg).

Others—*Leaf:* Extract exhibits antiviral properties. *Fruit:* Pericarp contains tannins (30–50%); used in India for a long time. Commercial extracts are prepared. Suitable for treating locomotive water, oil-drilling composition, ink-making, petroleum purification, cement, colouring slatestones, and as flocculent and anti-corrosion agent. Spent-pulp can be used for activated carbon, furfural, card-boards, adhesive resins, etc. Possesses purgative, stomachic, anthelmintic, tonic and alterative properties; exhibits antiinflammatory and antimicrobial activities. Used as an ingredient in several indigenous formulations for viral hepatitis, diabetes, *senile pruritus*, fatigue, anxiety neurosis, gastrointestinal disorders, vitiligo, gastric-ulcers, etc. Pulp used as a dentifrice to cure bleeding and with carron oil for burns and ulceration of gums and scalds. Fruit soaked in water is a good coolingwash for eyes in conjuctivitis. Cake can be used as manure. *Kernel:* Contains an oil (40%); possesses purgative propeties.

Root, bark, heartwood, sapwood and leaf also contain tannins.

THESPESIA Soland. ex Corrrêa (*Malvaceae*)

Trees and shrubs; tropics; 1 sp in India.

T. populnea Soland. ex Corrêa UMBRELLA-TREE, PORTIA-TREE, INDIAN TULIP-TREE

Beng–*Dumbla, parespipal;* Guj–*Paarsapeepala;* Hindi & Punjab–*Paraspipal;* Kan–*Hoovarase;* Mal–*Poovarasu;* Mar–*Bhendikejhar, parsachajhas;* Oriya–*Gunjausto, porosopipal;* Sans–*Gardhabhanda;* Tam–*Chelanthi, poovarasam kallai;* Tel–*Gangaraavichettu.*

Habit—A compact, quick-growing, evergreen tree, up to 20 m, with a clear bole of 2.5–6.0 m. *Bark*—grey to brown, fissured, often knobby, fibrous. *Leaf*—cordate-ovate, 7.15 cm long. *Flower*—yellow, with a purple base, becoming purple when withers, 5.0–7.5 cm; more or less throughout the year in tropics. *Fruit*—globose or oblong, brown capsule, with persistent calyx. *Seed*—flat, egg-shaped, pilose or powdery on surface; 6325/kg; December; germination 30–70%; viable even after prolonged exposure to salt-water.

Distribution and Ecology—Commonly found on the coasts of India and the Andamans; also cultivated for ornament and shade. Grows everywhere including saline soils, except hilly areas. Prefers light and porous soils. Thrives well on moist and warm situations, but can withstand temperatures as low as 4°C.

Cultivation/Regeneration–Can easily be raised from seeds or cuttings, seed-raising being preferred as timber is knot-free, straight- and even-grained and tough.

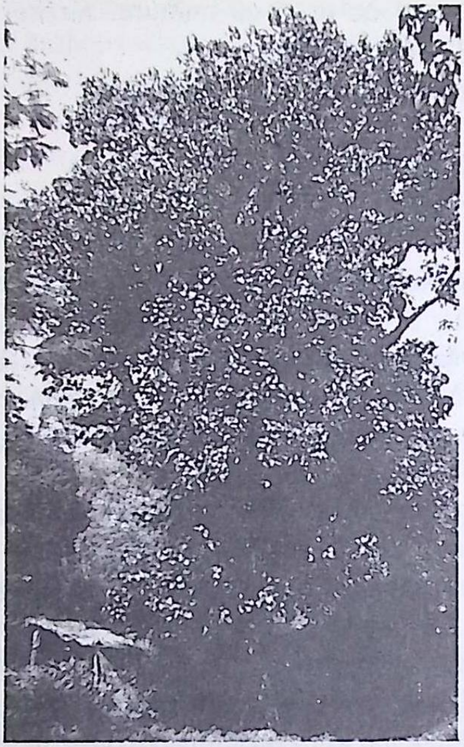
UTILIZATION

Reclamation—Grows everywhere including saline soils, except hilly areas; recommended for coastal regions, wetlands, red and sandy soils and waterlogged areas. Recommended for shelterbelts in coastal sand-drift areas and under social forestry. Leaf is lopped for manure.

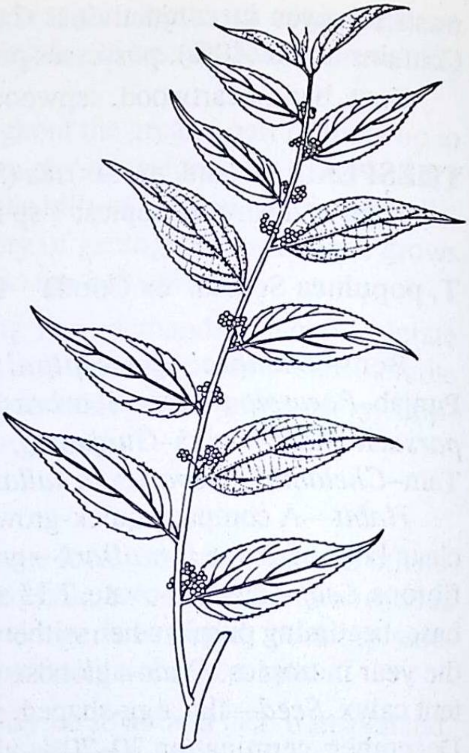
Timber—Known as SEYCHELLES ROSEWOOD. Gunstocks, carts, boat-building; agricultural implements, musical instruments, shuttles, furniture, clubs, and turnery.

Fuel—Used as firewood.

Fodder—Leaf lopped.



Thespesia populnea



Trema orientalis

Others—Bark: Yields fibre; used for cordage, fishing-lines and bags. *Leaf:* Young buds and leaves have pleasant taste and eaten either raw or fried; leaf-extract antibacterial. *Flower & Fruit:* Yield a yellow dye, used for silk and wool. Contains thespesin. *Seed:* Yields an oil (15%).

Bark, leaf, flower and fruit useful in cutaneous affections.

TREMA Lour. (*Ulmaceae*)

Evergreen trees and shrubs; tropics and sub-tropics; 3 spp in India.

T. orientalis Blume syn. *T. amboinensis* auct., non Blume; *Celtis orientalis* Linn. CHARCOAL-TREE, INDIAN NETTLE-TREE

Beng–*Chikan;* Guj & Mar–*Gol;* Hindi–*Gio;* Kan–*Gorklu;* Mal–*Ama;* Oriya–*Kharkas;* Tam–*Ambarathi;* Tel–*Budamuru, kaakammusti.*

Habit—A small, fast-growing, but short-lived, evergreen tree or a large shrub, up to 10 m/1.5 m. *Stem*—ringed with stipular scars, bearing straight, spreading branches. *Bark:* thin, smooth, white, greyish-green or bluish-green to greenish-brown, with numerous lenticels. *Leaf*—obliquely ovate-oblong or oblong-lanceolate or ovate with 7.5–15.0 cm. *Flower*—

monoecious, minute, whitish or greenish, male in compact cymes and female in lax cymes. *Fruit*—drupe, 4 mm long, black when ripe. *Seed*—small, 369,700/kg; March; germination 0–30%.

Distribution and Ecology—Almost throughout the moist parts of India, up to 2430 m. Grows very fast on forest-clearing, fallow-lands, landslips and exposed lands and in swampy areas.

Cultivation/Regeneration—Grows from seed. Can also be propagated from stumps.

UTILIZATION

Reclamation—A good soil-binder. Recommended for reclaiming forest-clearings, fallow- or wastelands, landslips, swampy areas, denuded hillslopes, roadsides and cuttings as it is most useful for reclothing such areas. Often planted as a shade-tree for coffee. Fixes nitrogen.

Timber—Tea-chests, matchboxes and splints, wooden shoes, fishing-boats, fine-quality particle-boards; and pulp.

Fuel—Poor firewood, but makes good charcoal (3095 kcal/kg).

Fodder—Tender leaf lopped.

Others—Bark: Yields tannins (16%), used for toughening and dyeing fishing-lines. Also, yileds a fibre, used for ropes, twine and a coarse cloth. *Leaf:* Mature ones used as sandpaper. *Root:* Employed in diarrhoea and passing of blood in urine. Alcoholic extract depresses blood-pressure. *Fruit:* Sweet and edible.

T. politoria (Linn.) Blume syn. *Sponia politoria* Planch., found in dry places in sub-tropical Himalayas and throughout North India from Gujarat to Assam, up to 1500 m, is very similar to *T. orientalis* in utility. A good soil-binder, suitable for afforestation, and comes up in profusion on landslips, abandoned lands and other exposed soils, such as denuded hilltops. Tender leaf given as fodder; fruit made into acidic jams. *T. cannabina* Lour. syn. *T. amboinensis* Blume, non auct.; *T. virgata* Blume (Beng–*Jibon;* Hindi–*Bakripathi;* Assam–*Pradamjola;* Lepcha–*Tugla-kung;* Santal–*Jhawar*) is very similar to *T. orientalis* and may be useful likewise.

ULEX Linn. (*Fabaceae*)

Spiny shrubs; native to Europe and North Africa, naturalized elsewhere; 1 sp introduced into India.

U. europaeus Linn. GORSE, FURSE, WHIN

Habit—A spiny weed, 60–120cm tall. *Branch*—striped, sometimes modified into subulate thorn. *Stem*—erect, many, terminal and lateral branches usually reduced to green spines. *Leaf*—3-foliolate in seedlings but reduced to scales or narrow spine-like phyllodes appearing simple. *Flower*—yellow, fragrant, solitary or in pairs, in the axils of spines, in short racemes or umbels crowded at the ends of branchlets. *Fruit*—ovoid or linear-oblong, dark brown, compressed or turgid, densely hairy, 1–6-seeded pod.

Distribution and Ecology—Introduced into India from England and Europe, grows wild in India over large areas on the Nilgiri, Palni and Kodaikanal hills; also found on the roadsides and field-boundaries; cultivated on the Shimla hills. Infested areas can be planted with *Eucalyptus globulus* and *Acacia mearnsii*. Also grown for ornament. Does not tolerate severe monsoon.

Cultivation/Regeneration—Propagated from seed and cuttings. Vigorously coppices.

UTILIZATION

Reclamation—A sand-binder, prevents soil-erosion by providing effective ground-cover on poor, sandy or rocky lands; can be planted on saline and alkaline soils and in cold deserts for reclamation. Withstands repeated cuttings producing new shoots; eradication difficult ones it establishes. Can be grown on calcium- and phosphorus-deficient soils. Serves as a good nursecrop. Fixes nitrogen.

Fuel—Used as firewood, but burns with explosive force.

Fodder—Browsed by goats and sheep when young. Cultivated as winter-fodder (crude protein, 4.6%; carotene, 159–253 mg/kg) and can be used as dry fodder. Not poisonous before flowering.

Others—*Leaf:* Substituted for tea in Africa. *Flower:* Yields a pleasant essential oil; blends well with well-known perfumes; used in cosmetics for toning, as restorative and emollient. *Seed:* Yields anti-H lectin; used in clinical laboratories for separation of secretors and non secretors, and in diagnosis of A and AB human-blood groups.

VETIVERIA Lem.-Lisanc. (*Poaceae*)

Perennial grasses; found in tropics of the Old World; 2 spp in India. Roots yield an aromatic oil, known as VETIVEROIL.

V. zizanioides (Linn.) Nash syn. *Andropogon muricatus* Retz.; *A. squarrosus* Hook.f., non Linn. f.; *Anatherum zizanioides* (Linn.) Hitchcock & Chase

VETIVER, KHAS-KHAS

Beng & Hindi–*Khas-khas*, *khus;* Guj–*Valo;* Kan–*Vattiveeru;*

Mal–*Ramaccham, vettiveru;* Mar–*Vala;* Sans–*Sugandhimoolam;* Tam–*Vettiveru;* Tel–*Vettiveeru, kuruveeru.*

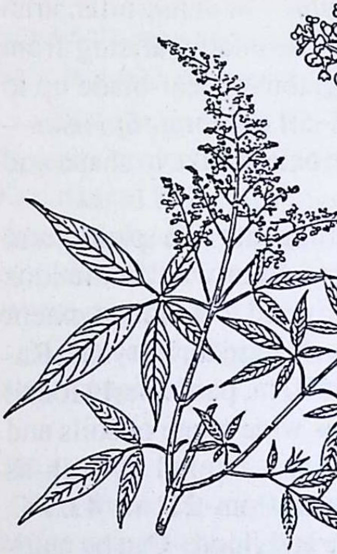
Habit—A densely tufted, perennial grass. *Culm*—in dense tufts, arising from aromatic rhizomes, 4 m or more. *Root*—aromatic, arising from rhizomes, spongy. *Leaf*—narrow, erect, keeled, glabrous, leaf-blade up to 90 cm long. *Inflorescence*—oblong, panicle, 13–50 cm long. *Spikelet*—grey-green or purple, 4–6 mm long, in pairs, more or less alike in shape and size, different in sex, male pedicelled.

Distribution and Ecology—Indigenous; throughout the plains and lower hills. Although the bulk of roots is obtained from wild formations from many states, the grass is systematically cultivated to a limited extent in Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Punjab, Haryana, Rajasthan and Uttar Pradesh from sealevel up to *c* 2600 m, particularly found on the river-banks and rich, marshy soil. Tolerates wide range of soils and climate; luxuriant in hot and humid climates with a rainfall as high as 5000 mm or as low as 200 mm and temperature from 21° to 43.5°C. Drought-resistant; withstands snow. Survives fire and flood. Can be cultivated on sandy loam, swamps, waterlogged areas or even near seashore and in alkaline and also saline lands, although a rich and well-drained sandy loam is considered the best.

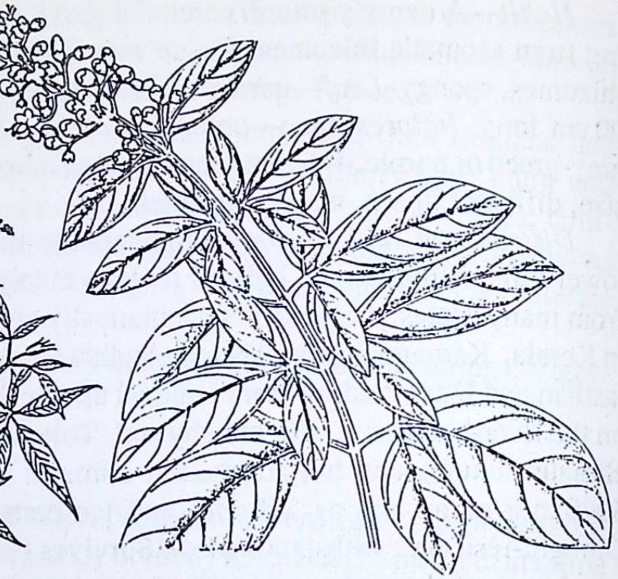
Cultivation/Regeneration—Vegetative slips, separated from the clumps with intact rhizome having 15–20 cm of the shoot, are used for planting at the beginning of rainy season in well-ploughed lands at 20–22 cm. Although seed-sowing is not very popular, seed is sown in nursery in early January and the seedlings are transplanted to the well-prepared and ridged field with the onset of premonsoonal showers; 1.50–2.25-lakh slips needed per hectare. No further attention is normally required except 3–4 weedings in the first year. Manures, such as ash, compost and sweepings from fish-cured yards, increase yield. In Kerala, ammonium sulphate, groundnut cake and fish-cured brine increase the yield of oil. Irrigation is given in some places; once establishes, it requires little water. Normally harvested during dry seasons, when 10–18 months, depending upon the utility; yield 4000–7600 kg fresh root/ha under cultural conditions.

UTILIZATION

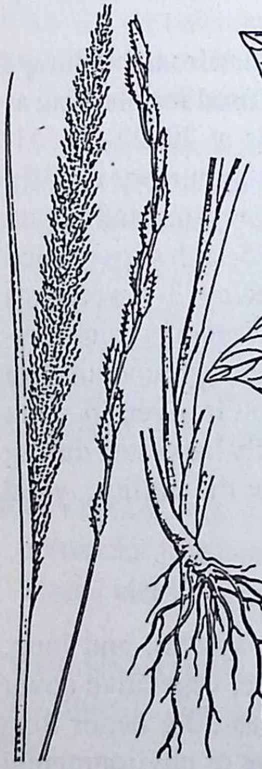
Reclamation—With its deep, strong fibrous root-system, and long, narrow, thick leaves the plant forms an excellent, dense, vegetative cover for controlling soil-erosion, even on slopes as steep as 50% better than several other plants. Being very hardy with wide range of environmental tolerance, the grass can be grown in hot, sandy, sandy-loam, marshy, waterlogged and alkaline and probably also on saline lands. It can be planted for checking erosion in farms, and siltation in contour canals and reservoirs;



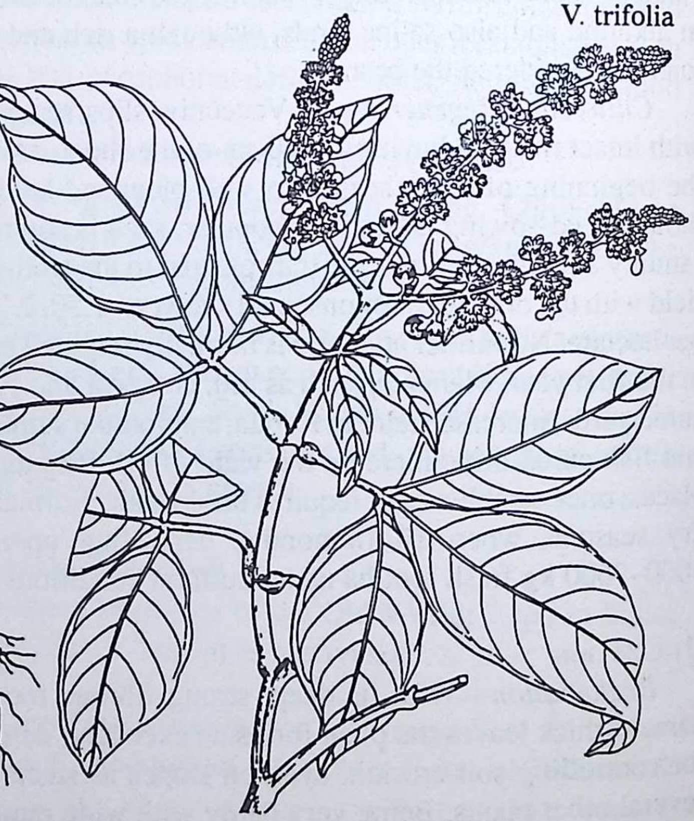
Vitex negundo



V. trifolia



Vetiveria zizanioides



Vitex pinnata

also prevents erosion caused by water. The cultivars with non-viable seeds do not become weeds. Successive planting of this crop is, however, reported to deplete the land and harbour many diseases. Regular harvesting of the whole rootsystem for the aromatic roots again leads to erosion till the new plants establish and the efforts for preventing erosion will be defeated. Hence, it may be suggested to restrict the harvest of the roots to the central area, of the standing crop, leaving thick, hedge-like boundary line totally undisturbed. Not only this practice gives the much-needed economic return to the grower but improves soil, largely checks erosion and conserves moisture in the upland areas and encourages penetration. Hence, its cultivation for preventing erosion and developing wastelands needs careful attention. Since the tender grass is browsed by goats and sheep and other cattle, the planted area needs protection Forms effective windbreak.

Fodder—Tender leaf (crude protein, 6.1–6.7%) browsed.

Others—Grass: Used for brooms and thatching; rachis used for furniture. Used in liver disorders and as refrigerant, febrifuge, stimulant, stomachic and aphrodisiac. Suitable for pulp. *Root:* Yields a fragrant, aromatic oil (up to 2%); mainly used as a fixative in perfumes and for blending in cosmetics and soaps. Oil possesses antimicrobial and antipodal properties. Two oils, highly laevorotatory oil from the wild roots of North India and dextrorotatory oil from the cultivated roots of South India, are obtained. Used as a stimulant, carminative, refrigerant and diaphoretic; also applied in rheumatism. Root infusion considered tonic for brain and heart; and used in headache and toothache. An extract exhibits CNS-depressant activity. Screens, mats, hand-fans and window- and door-covers are made from roots for cooling effect.

VITEX Linn. (*Verbenaceae*)

Trees or shrubs; tropics and warm-temperate regions; 14 spp in India. Some are useful in social forestry.

V. negundo Linn.

Beng–*Nisinda, nirgundi;* Guj–*Nagoda;* Hindi–*Nisuidee, sambhalu;* Kan–*Nakkilu;* Mal–*Vellanocchi;* Mar–*Nirgundi;* Oriya–*Begundiya, nirgundi;* Tam–*Vellainocchi, nirkkundi;* Tel–*Tellavaavili, vaavili.*

Assam–*Pasutia;* Kumaun–*Shiwali;* Punjab—*Banna.*

Habit—A large, aromatic shrub or a small, slender tree, with quadrangular, densely whitish-tomentose branchlets, up to 4.5 m. *Bark*—thin, grey. *Leaf*—3–5-foliolate: leaflets lanceolate, entire or rarely crenate. *Flower*—bluish-purple, small, in peduncled cymes, forming large, terminal often compound, pyramidal panicles. *Fruit*—globose drupe, black when ripe, 5–6 mm diam, with persistent calyx.

Distribution and Ecology—Often gregariously found throughout the greater part of India, up to *c* 1500 m in outer Himalayas. Widely planted as hedge in gardens, roadsides and field-borders. Abundant along the river-banks in moist-situations, open wastelands, and near the deciduous forests, it has no preference for any specific soil; grows equally well on deep alluvial soils as well as on soils with rocky substratum. Possesses fair degree of tolerance to alkalinity.

Cultivation/Regeneration—Can easily be propagated from cuttings and rootsuckers.

UTILIZATION

Reclamation—Denuded hilltops and mined wastelands can be reclaimed. Very useful to control soil-erosion, and for afforestation of forest-lands affected by floods; suitable for control of streambanks and landslides; also widely planted as hedge in parks, roadsides and field-borders. Recommended for social forestry and for shelterbelts and windbreaks.

Others—*Bark:* Powder used in sciatica. *Shoot:* Used in basket-making. *Leaf:* Tonic and vermifuge. Gives relief from headache and catarrh and rheumatic affection. Juice considered abortifacient; ointment made from it applied as a hair-tonic. Extracts possess antibacterial, CNS-depressant, anti-inflammatory, analgesic, anticancer and insecticidal properties and beneficial in sciatica. Yields an essential oil (0.04–0.07%). *Root:* Tonic, febrifugal, expectorant and diuretic. Powdered roots along with parasite (*Alectra parasitica*), which grows on *Vitex negudo*, is effective in leprosy treatment. *Flower:* Astringent; used in fever, diarrhoea and liver complaints. Juice used in leprosy and skin-diseases. *Fruit:* Boiled and eaten. Extracts exhibit diuretic, anti-inflammatory and antifertility activities.

V. pinnata Linn. syn. *V. pubescens* Vahl (Mal–*Attamayila;* Oriya–*Dhalasingha;* Tam–*Myladi;* Tel–*Nowlieraagu*, *nevaladuga;* Assam–*Ahoi*, *dieng-lakhiet-dkhar;* Tripura–*Arekodol*) is a moderate-sized to large, ornamental tree, found in South India, extending North-eastwards to Orissa, and in Tripura and Assam, up to *c* 900 m. Mostly met with along the banks of the streams in South India; can grow on rather poor soils and also useful for reforestation. Timber used for construction, agricultural implements and turnery and inlay work.

V. trifolia Linn. (Beng–*Panisamalu;* Hindi–*Pani-ki-san-bhalu;* Kan–*Lakhi;* Mal–*Karinoche;* Mar–*Lingur, indrani;* Oriya–*Begundia;* Tam–*Nirnocchi;* Tel–*Chiruvaavili*) is a stout, aromatic shrub or a small tree, found from the foot of the Himalayas southwards throughout the greater part of India and in the Andamans. It is very hardy, and met with even on poor soils and dry localities. Often cultivated, especially for hedges. Suitable for planting on beachsand for stabilization.

XANTHIUM Linn. (*Asteraceae*)

Monoeciuous herbs; tropics and temeperate regions; 2 spp introduced into India.

X. strumarium Linn. BURWEED, COCKLEBUR

Beng–*Banokra, chota-dhatura;* Guj–*Gadariun;* Hindi–*Banokra, chotadhatura, chotagokhru;* Kan–*Maruluummatti;* Mar–*Shankeshvarā;* Sans–*Arishta;* Tam–*Maruloomatham;* Tel–*Marulamathangi.*

Assam–*Agara;* Garo–*Lokra;* Jammu & Kashmir–*Tsur;* Khasi–*Gaghra;* Madhya Pradesh–*Adhasisi;* Mikir–*Parohanthor;* Punjab–*Wangan.*

Habit—A coarse, unarmed annual, up to 1.5 m. *Leaf*—triangular-cordate or sub-orbicular, often 3-lobed, irregularly toothed, cuneate at the apex, scabrid or hispid. *Flowerheads*—numerous, white or green, in terminal or axillary racemes: male upper most, globose, numerous; female ovoid, covered with hooked bristles, terminating in 2, strong, hooked beaks. *Fruit*—obovoid, enclosed in the hardened involucre, with 2 hooked beaks and hooked bristles. *Flowering & Fruiting*—end of rainy season.

Distribution and Ecology—Native to South America, naturalized as a weed throughout India in dry paddy-fields, deep sandy soils, tankbeds, and waste places, up to 1500 m in the Himalayas; also found in brackish water, Rajasthan desert, graded riverbed, and rocky areas.

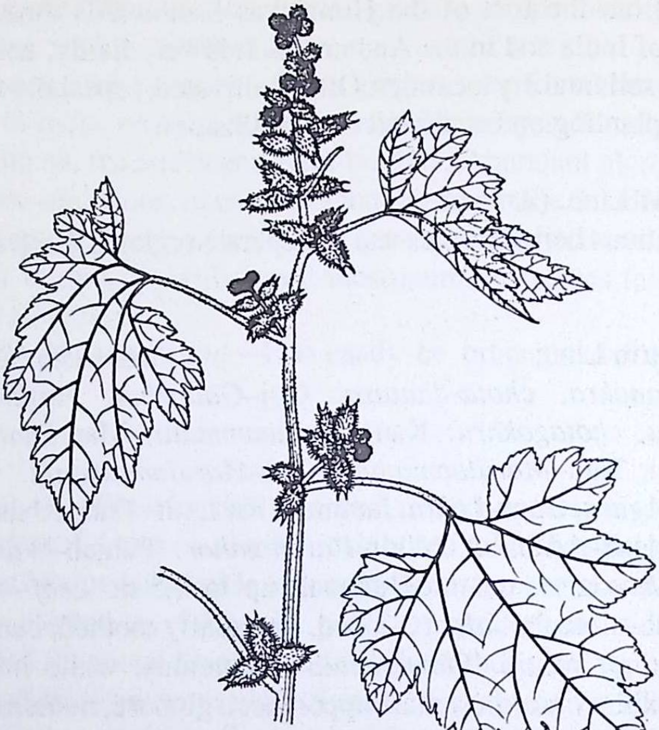
Cultivation/Regeneration—Easy to grow from seed. Very easily dispersed through animals as the fruits have hooked bristles and 2 strong hooked beaks.

UTILIZATION

Reclamation—Recommended for afforestation of marshy wastelands, rocky areas and desert areas. Suitable as organic manure as it increases nitrogen in soil.

Fuel—Dry stems can be used.

Others—Plant: Diaphoretic, diuretic, sedative, styptic and given in urinogenital diseases; but produces dermatitis. Yields xanthinin; useful as a CNS-depressant; and a patented medicine is available. Xanthinin acts as a growth-regulator for plants and shows antibacterial activity. Extracts exhibit anticancer and hypoglycaemic activities. *Leaf:* Boiled and used as



Xanthium strumarium

vegetable with young floral tops; used in scrofula and herpes. Yields an essential oil (0.01%); active against pathogenic and non-pathogenic fungi; also yields a yellow dye. *Root:* Considered tonic; possesses hypoglycaemic activity. Aqueous and methanolic extracts show anticancer activity. *Fruit:* Used as anti-inflammatory due to β-sitosterol-β-D-glucoside which is incorporated into food or medicines to regulate hormonal activity and treat urinogenital diseases. Possesses a compound which exhibits antidiabetic activity in rats. Toxic to cattle. *Seed:* Yields a semi-drying, edible oil (30–35%), resembling that of sunflower; useful in treating bladder affections, herpes and erysipelas. May be useful in various industries, such as soap, oil, paint, alkyds, licithin, and paper. *Cake:* Highly suitable as manure. *Shell:* Useful for activated carbon and for furfural.

YUCCA Linn. (*Agavaceae*)

Evergreen, ornamental shrubby plants; native to Mexico, West Indies, and the USA, particularly in the arid regions, introduced elsewhere; 4 spp introduced into India.

Yucca spp, commonly known as ADAM'S NEEDLE, SPANISH-BAYONET, BEARGRASS, MOUND-LILY YUCCA, SOAPWEED, prefer well-aerated, light and fertile soils where the watertable is not too high. They can be propagated from seeds, cuttings and suckers but the best method is through planting 7.5–10.0 cm long rhizomes (20,000/ha) in rows *c* 10 cm deep in the soil. Field may be hoed and weeded. Fertilizers and trace-elements, such as manganese, zinc and boron, are beneficial.

Yucca spp can also be grown as windbreaks and on wasteplaces to prevent erosion. Many of the *Yucca* spp are grown for ornament. These species are an important source of steroidal sapogenins, precursors of oral contraceptives and sex-hormones. Other medicinally useful steroids also are present.

The trunks of *Yucca* spp furnish valuable emergency feed; panicles are also much eaten by cattle. They are also used as stockade and for walls of houses; the leaves are used for thatching. The fibre from leaves is generally tenacious, hard and comparable in tensile strength to sisal, jute and hemp, employed for making paper, sails, brushes, mats and baskets, linen and canvas, and also for 'balsom wool' used for insulation.

The underground parts possess detergent properties and are used for washing or as an ingredient in toilet-soap.

Flower-buds or fresh flowers are eaten raw as a salad, or differently cooked. Fleshy fruits are also edible and an alcoholic beverage is prepared from them.

Y. gloriosa Linn.

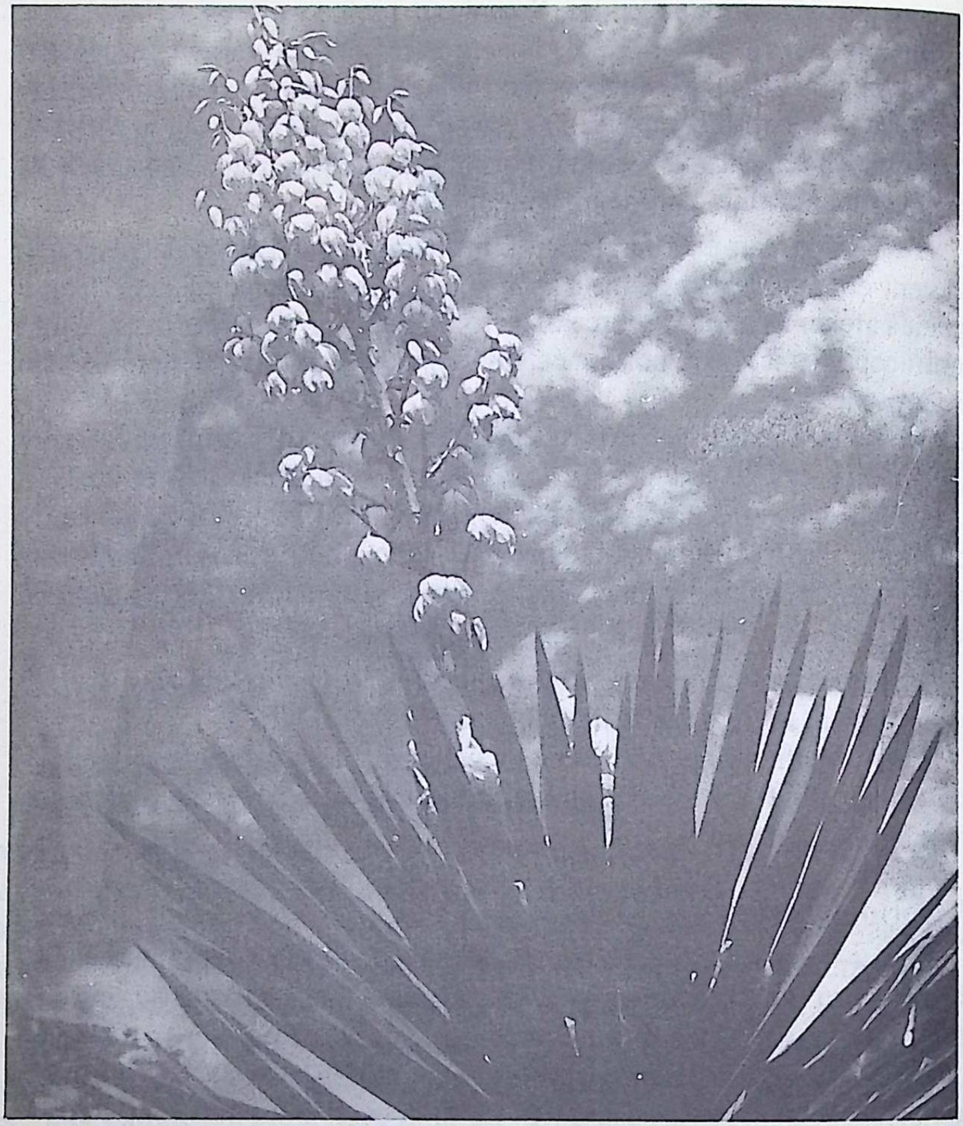
Habit—An acaulescent or short-trunked, branched or unbranched shrub, up to 3.4 m. *Leaf*—up to 75 cm long × 5 cm wide, stiff, smooth, forming a crown at the ground or at the summit of the trunk. *Flower*—greenish-white, reddish or purplish-tinged, closely packed in a narrowly conical, solitary, central scape, 1.0–1.8 m or even more in height. *Fruit*—dry, drooping capsule.

Distribution—Native to America, introduced into India as a garden-plant; found in many localities but naturalized at some places in the Himalayas and in Tamil Nadu.

UTILIZATION

Reclamation—Plant of arid region and may be grown to reclaim the soils in such areas and prevent erosion. Grown for ornament in the rockeries in gardens.

Others—Plant: Several sapogenins have been reported from various



Yucca gloriosa

parts of the plant. *Leaf:* Ethanolic extract possesses antifungal and a CNS-depressant activity. *Rhizome:* Used for making arrowroot. Used as detergent.

ZIZIPHUS Mill. (*Rhamnaceae*)

Deciduous or evergreen trees and shrubs; dry, hot and arid tracts of tropics and sub-tropics; 17 spp wild in India and a few introduced.

Z. jujuba Mill., non Lam.; *Z. sativa* Gaertn.; *Z. vulgaris* Lam.

Hindi–*Banober*.

Bombay–*Ranbor;* Kashmir–*Bary konkamber;* Punjab–*Barari.*

Habit—A deciduous tree, up to 12 m, sometimes a large bush. *Leaf*—ovate to oblong-ovate or nearly lanceolate, 2.5–5.0 cm long, obtusely serrate. *Fruit*—oblong to ovoid or subglobose, 3 cm or less. *Seed*—1800/kg; December; germination 30–70%.

Distribution and Ecology—Probably native to China, cultivated and naturalized in Punjab. Found in sandy and arid tracts and grows on salty areas.

Cultivation/Regeneration—Propagated from layering or grafting.

UTILIZATION

Reclamation—Recommended for alkaline, saline, arid sandy and sand-dune tracts and waterlogged areas for reclamation. Recommended for agro- and social forestry. Grows as a hedge for fencing.

Timber—Combs; and turnery articles.

Fodder—Leaf lopped. Fruit also fed to cattle.

Others—*Leaf:* Laxative; used for scabies and throat troubles. *Bark:* Yields tannins (7%). *Fruit:* Those from cultivated plants are nutritious and eaten dried, steamed and preserved in sugar; wild ones are considered cooling, anodyne and tonic. Externally used in poultices and applications for wounds. Used as an ingredient of a unani drug for common cold. Juice used in cosmetics, especially skin-creams. *Seed:* Kernel edible; increases flesh and strength.

Z. mauritiana Lam. syn. *Z. jujuba* Lam., non Mill. INDIAN JUJUBE; COMMON JUJUBE

Beng & Hindi–*Ber;* Guj–*Bordi;* Kan–*Elanji;* Mal & Tam–*Elentha;* Mar–*Bera, bor;* Oriya–*Bodori;* Sans–*Karakandhy;* Tel–*Reegu, gangareegu.*

Habit—A small, evergreen tree of variable size, up to 15 cm or more with a spreading crown and stipular spines, but more commonly as a compact shrub of 3–4 m. *Bark*—rough, grey or dull black. *Leaf*—variable, oblong-elliptic, ovate or suborbicular, closely serrulate or entire, rounded at both ends, prominently 3-nerved. *Flower*—greenish-yellow, in axillary cymes; April–October. *Fruit*—oblong-globose or ovoid, reddish-brown, orange or yellowish, 1-seeded drupe, October–March. *Seed*—shape depends upon fruit; 1240–1760/kg; germination 16–87days, kernel 7 days, 31–95%; viable for 30 months; needs treatment with 500 ppm thiourea or soaking in water.

Distribution and Ecology—Wild throughout the greater part of India, up to 1500 m; cultivated for its hardy fruit in many states with dry climate. Found thriving in dry regions on riverbeds, sandy or shingly alluvium or sand-dunes, but can grow on a variety of other soils including laterite, black cotton-soils or even moderately saline and alkaline loams.

Silvicultural Characters—A strong-light demander; even seeds need light for germination. Hardy and not much affected by excessive dry heat, or by frost, or hot winds or drought; and hot, dry climate ideal for cultivation and establishes under marginal conditions. Vigorously grows from rootsuckers. Coppices well.

CULTIVATION/REGENERATION

Natural Regeneration—Seeds, dispersed through the excreta of birds and animals, if covered or burried in loose soil till monsoon, germinate during the first half of rainy season. Generally profuse. Plants can be thinned out to 11–12 m or by proper pruning to 7–8 m.

Artificial Regeneration—May be propagated from direct sowing or transplanting seedlings, stem-cuttings or rootsuckers or stumps. Budded or grafted trees are comparatively more vigorous for commercial plantations. Seed-raised (April–May) plants should carefully be transplanted (July); even budded plants can be transplanted. Young plants respond well to irrigation when hot; also irrigation improves fruiting. Farmyard manure is helpful. Addition of ammonium sulphate (0.5 kg/year-age/tree) along with FYM is recommended. Young plants are supported and trained and pruned in the early years. Regular pruning of shoots and removal of old shoots help in more yield and should be done during the dormant period. A few diseases and pests have been recorded.

UTILIZATION

Reclamation—Recommended for arid, semi-arid regions and for agro- and social forestry. Can be grown for reclaiming moderately saline soils, alkaline loam, sandy gravelly alluvium, neutral soils, etc. Can be irrigated with saline water; frequently associated with *Acacia catechu*. Grown as windbreaks, shelterbelts and live-hedge. Host for lac-insect.

Timber—Wells, axes, toolhandles, gunstocks, sandals, yokes, harrows, toys, turnery; and activated carbon.

Fuel—Good for firewood (sapwood, 4878kcal/kg) and charcoal.

Fodder—Leaf lopped for fodder (crude protein, 12.9–16.9%); given for *tasar*-silkworms.

Others—*Leaf:* Astringent; eaten with catechu; diaphoretic. Used in skin-diseases and as poultice. Extract exhibits local anaesthetic effect.

Bark: Yields tannins (4–9%); decoction given in diarrhoea and dysentery. *Fruit:* Eaten fresh (protein, 0.8%); dried like raisins, candied, stewed or smoked; contains vitamin-C and minerals. Cooling, anodyne, tonic. Forms a constituent of medicines for chest and leprosy. *Kernel:* Sedative, soporific; prescribed in nausea, vomiting; used as poultice for wounds. Yields an oil (33%). *Seed:* Used in diarrhoea and as contraceptive.

Z. nummularia (Burm.f.) Wight & Arn. syn. *Z. routndifolia* Lam.; *Rhamnus nummularia* Burm.f. WILD JUJUBE

Guj–*Chanyabor;* Hindi–*Jhahrberi;* Mar–*Junglaber;* Tam–*Korgodi;* Tal–*Neelareegu.*

Bombay–*Chanibor;* Delhi–*Jhahrberi;* Punjab–*Jangra;* Rajasthan–*Bordi.*

Habit—A thorny, small bush or a shrub, with widely divaricating, flexuous, pale-purplish stems and or grey-velvety stiplular prickles in pairs. *Leaf*—ovate to orbicular, densely tomentose beneath, serrate. *Flower*—pale yellow, in axillary cymes. *Fruit*—red or black drupe, 1cm long; November; germination 7days, 30%.

Distribution and Ecology—Punjab and Rajasthan extending into peninsular India, up to *c* 900 m. A mixed xeromphic plant abundant in grazing lands of the arid and semi-arid areas. Thrives in the driest localities and on rocky area. In Rajasthan, it forms *c* 14% of the total flora of grasslands; frequently occurs in the cultivated fields and sometimes becomes a troublesome weed; and also in woodlands with deep deposition of sand, sandy and alluvial loam, shallow sandy loam. Rainfall required is 150–400 mm.

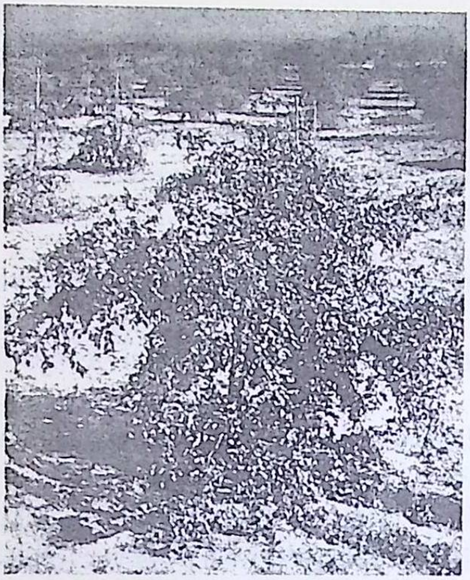
CULTIVATION/REGENERATION

Natural Regeneration—Takes place through seeds and rootsuckers.

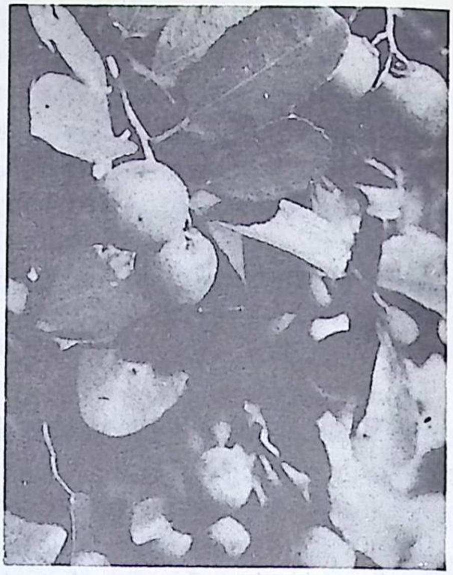
Artificial Regeneration—From seeds and rootsuckers. May be planted in overgrazed lands, depressions, and in rocky and semi-rocky sites. Because of deep rootsystem, it thrives on shallow soils and in the driest of localities. In sandy soils, planting is done in 60 cm pits. Transplanting one-year-old, potted seedlings during monsoon gives high survival and results in good stand in the field. Young plants need protection from browsing, though withstands fairly well.

UTILIZATION

Reclamation—Very hardy and thrifty with regard to nutrients and moisture. Thrives on shallow soils and in the arid localities with its deep rootsysten. Recommended for overgrazed lands, depressions, rocky, semi-



Ziziphus jujuba



Z. xylopyra

Z. nummularia

rocky sites, saline soils, sandy alluvial and loam, sand-dunes, mineral soils and *babhar* tracts. Checks wind-erosion; helps in deposition of soil in and around them and allow other grasses to grow. Also used for fencing. Used for shelterbelts, windbreaks and hedges in Rajasthan desert. Can be used for top-working with the cultivars of *Z. mauritiana*. Host for lac-insect.

Fuel—Yields a good-quality firewood and charcoal (5620 kcal/kg).

Fodder—Grazed by animals when young and tender (crude protein, 14.7%); but only sheep and goats graze the mature plant. Abundantly available when other grasses have dried. With good management, it should form an integral part of grassland-improvement plans in arid areas. Suggested that the feed should be mixed with other fodders.

Others—Twig-bark: Yields tannins (12%). *Leaf:* Used in skin-diseases, such as scabies. Smoke inhaled in colds and coughs. *Fruit:* Pleasantly subacidic and eaten; dried powder preserved for use. Given for cooling, astringency and biliousness.

Z . xylopyra Willd. incl. **Z. glaberrima* Sant.

Hindi–*Kat-ber;* Kan–*Mullukare;* Mar–*Koddntegoti;* Oriya–*Goteoboro, kantobohul;* Tam–*Kottei;* Tel–*Gotte*.

Habit—A large, straggling shrub or a small tree, armed with spines, up to 4 m, covered with short, greyish tomentum. *Leaf*—broadly elliptic, obovate or orbicular, serrulate, glabrous, dark above and covered with soft and pale tomentum beneath, oblique. *Flower*—yellowish-green, in compact cymes; April–June. *Fruit*—globose, 3- or rarely 2- or 4-celled, with usually a seed in each. *Seed*—very hard, woody; January–April; viable for *c* 30 months but decreases with age.

Distribution and Ecology—North-western India, Uttar Pradesh, Bihar and Central and South India. Common in certain dry, open deciduous or scrub-forests and grasslands, often forming impenetrable thickets when young; and springs up in the blanks in the *sal*- forests of the sub-Himalayan tracts

Silvicultural Characters—A light-demander. Withstands drought well. Coppice-growth fairly rapid.

UTILIZATION

Reclamation—Plants form impenetrable thickets and can be utilized as windbreak and for preventing erosion.

A host for lac-insect.

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* Mentioned under *Z. xylopyra* in various floras though distinct; but both are similarly used.

Timber—Agricultural implements, cart-wheels; and toolhandles.
Fuel—Used for firewood (sapwood, 4874 kcal/kg) and charcoal.
Fodder—Leaf lopped.

Others—Extract of aerial parts exhibits antiviral and CNS-depressant activity. *Bark & Fruit:* Yield tannins 7% and 8–12%, respectively; used for tanning hides and skins. *Seed:* Yields an oil (10%).

Z. oenoplia Mill. (JACKAL JUJUBE; Beng–*Siakul;* Hindi–*Makai;* Kan–*Barige;* Mal–*Kottavalli;* Mar–*Kanerballi;* Oriya–*Kantokolli;* Tam–*Ambulam;* Tel–*Banka-paragi*) and *Z. rugosa.* Lam. (Hindi & Mar–*Churna*; Mal–*Malantutali;* Oriya–*Simukoli;* Tam–*Kattilandai;* Tel–*Pinduparighamu;* Santal–*Sekra.*), found throughout the hotter parts of India, used for hedges and heaped-up fences. Fruits eaten. Extract of aerial parts exhibits diuretic and hypotensive activity. Bark-extract possesses anti-inflammatory and anti-cholinergic activity.

Z. spinachristii Willd., native to North Africa and West Asia, introduced into India, suitable for arid and semi-arid regions; host for lac-insect. Leaf given as fodder (crude protein, 12.5%). Bark contains tannins (9.3%). Yields edible fruits; seeds yield a fatty oil (29.4%).

ZYGOPHYLLUM Linn. (*Zygophyllaceae*)

Small, much-branched herbs or subshrubs with fleshy branches; Old World, chiefly in the drier parts of Africa and Australia; 1 sp in India.

Z. simplex Linn.

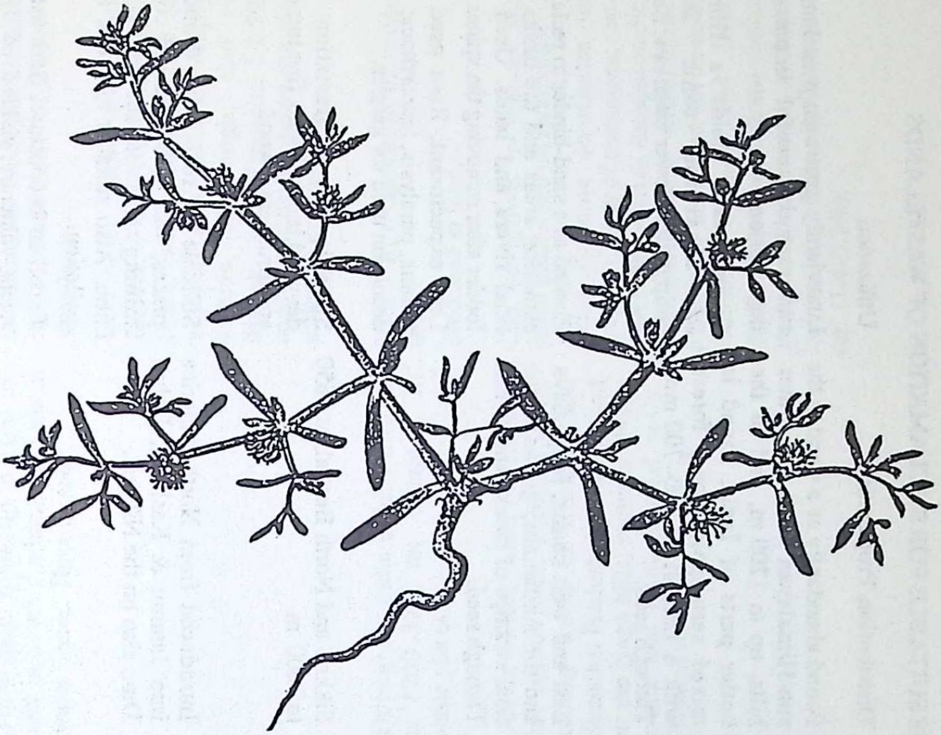
Punjab & Rajasthan–*Alethi.*

Habit—A succulent, much-branched, prostrate or ascending annual. *Leaf*—unifoliolate, 0.60–1.25 cm long, sessile, fleshy, obtuse. *Flower*—white or yellow, with red or purple spots at the base. *Fruit*—4–5-angled capsule, with 5, compressed, 2–3-seeded cocci. *Seed*—smooth, fusiform.

Distribution and Ecology—Drier parts of Punjab, Rajasthan and Gujarat. A halophyte found in dry areas, graded riverbeds, saline flats and depressions.

UTILIZATION

Reclamation—May be grown to reduce salinity in the soils and reclaim them as the leaves, stems and roots seem to absorb considerable amount of salt. Care is needed to prevent the salt-accumulating organs, particularly leaves, mixing with the soil again.



Zygophyllum simplex

Fodder—Leaf given to camels.

Others—Leaf, Root & Seed: Infusion of leaf and seed applied in eye-diseases. Extracts of leaf and root possess antimicrobial properties. Considered to be anthelmintic.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Abutilon indicum (Linn.) Sweet (*Malvaceae*) (COUNTRY-MALLOW; Beng–*Jhampi;* Guj–*Khapat;* Hindi–*Kanghi;* Kan–*Srimudrigida;* Mal–*Jhonkaped;* Mar–*Chakrabhenda;* Oriya–*Nakochono;* Tam–*Thuttli;* Tel– *Botlabenda, tuttilibenda;* Assam–*Jhapa;* Goa–*Petari*).	Herbaceous or shrubby, softly tomentose perennial, up to 3 m.	Found abundantly as a weed in the sub-Himalayan tract and other hills, up to 1200 m, and in the hotter parts of India; found in mixed xeromphic thorny forest, with a rainfall of 300–700 mm. Through seed.	Luxuriantly grows on wastelands and may be useful in preventing erosion. Green plant yields a fibre. Root a nervine tonic and antipyretic. Flower eaten raw. Seed laxative.
Acanthus ilicifolius Linn. (*Acanthaceae*) SEA-HOLLY; Beng–*Harkuchkanta;* Hindi–*Hargoza;* Kan–*Holechudi;* Mal–*Chakkaramulli;* Mar–*Marandi;* Oriya–*Harkanchi;* Tam–*Attumulli;* Tel–*Alchi*).	Gregarious, sparingly branched, evergreen shrub, up to 1.5 m.	East and west coasts; Meghalaya and the Andamans; grows in the tidal swamps of creeks and rivers. Through seed.	Planted as a sand-binder to reclaim estuarine areas and the banks of tidal rivers and lakes. Used as fodder after removing the spines. Leaf expectorant. Root used in asthma, paralysis, leucorrhoea; its decoction used for gargles.
Acer campbellii Hook. f.& Thoms. ex Hiren. emend Banerji (*Aceraceae*) (HIMALAYAN MAPLE; Beng–*Kabashi;* Lepcha–*Daom, yatlikung*).	Moderate-sized, fast-growing, deciduous tree, up to 36 m /up to 4 m.	Sikkim and North Bengal, at 1650 to 3000 m.	Suitable for afforestation of denuded lands. Yields fine turnery and ornamental wood.
A. negundo Linn. (ASH-LEAVED MAPLE, BOXELDER).	Deciduous tree, up to 21 m/ up to 1.2 m, with a spreading crown.	Introduced from North America into Jammu & Kashmir, Dehra Dun; also on the Nilgiris.	Suitable for reclaiming denuded places, wet soils, and old coal-mining regions for stabilization. Also suitable to check air-pollution. Excellent beepasture. Bark astringent, vulnerary; yields a red dye.

Achyranthes aspera Linn. (*Amaranthaceae*) (PRICKLY CHAFF-FLOWER; Beng, Hindi, Mundari, MP, Punjab–*Chirchitti, chirchira;* Guj & Mar–*Aghada;* Kan–*Utrani-gida;* Mal–*Kadalaadi;* Oriya & Sans–*Apamaranga;* Tam–*Chiru-kadaladi;* Tel–*Uttareeni;* Assam–*Chik-kairek;* Cachar–*Samsongi;* Garo–*Champang-michel;* HP–*Puthkanda;* Rajasthan–*Untaghada;* Santal–*Chipchirit*).	Erect or procumbent, variable annual or perennial herb, up to 2 m, with woody base.	Throughout India, up to 2100 m, and in South Andaman Islands in waste places. Through seed.	Luxuriant on waste places; useful in reclamation of several wastelands. Leaf eaten. Bark-extract abortifacient. Plant yields achyaranthine which dialates blood-vessels. Ash used in dropsy, asthma and cough; also in dyeing. Seed (protein, 22.5%) cooked and eaten; shows stimulant action on myocardium.
A. bidentata Blume (Assam–*Apamarang;* Lushai–*Uangvathur*).	Erect or ascending annual or perennial herb or shrub, with woody rootstock.	Throughout India in hilly districts at 1200–3200 m; common in waste places.	Useful in reclamation of wastelands. Seed used as food.
Acorus calamus Linn. (*Araceae*) (SWEETFLAG, SWEETROOT; Beng, Hindi & Assam–*Bach;* Guj & Mar–*Vekhand;* Kan–*Baje;* Mal–*Vayampa;* Tam–*Vashambu;* Tel–*Vasa*).	Semi-aquatic, aromatic, perennial herb, with creeping rhizome.	Grows wild; also cultivated throughout India. Plentiful in the marshy tracts of Kashmir and Himachal Pradesh, in Manipur and on the Naga hills; requires clayey loams and light alluvial soils. Through rhizome.	Can be grown in marshy and moist places and on riverbanks. Dried rhizome constitutes the drug CALAMUS of commerce, considered to possess antispasmodic, carminative and anthelmintic properties; also used for mental ailments, kidney and liver troubles. Powdered rhizome used as an insecticide. Rhizome, root and leaf yield a volatile oil, CALAMUS OIL (1.4–3.1%).

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Acrostichum aureum Linn. (*Pteridaceae*).	Large, handsome, terrestrial fern, up to 2 m.	Throughout India; mainly on Uttara Kannada coast, and in West Bengal and Orissa. Through rhizome.	Can be grown in the tidal backwaters, salt-water marshes and creeks along the coast; useful for reclamation of estuaries. Young frond edible; dried frond used for thatching. Paste of rhizome applied for wounds and bites.
Actinodaphne angustifolia Nees syn. *A. hookeri* Meissn. (*Lauraceae*) (Kan–*Hoggodgimara;* Mal–*Malavirinji;* Mar–*Gulchal;* Oriya–*Jarchampa;* Tam–*Thali;* Assam–*Petarichawa;* TRADE–*Pisa*).	Tree or shrub, up to 20 m/up to 1.4 m. *Fl.* & *Fr.*: May–June.	Evergreen forests of eastern and western ghats, Sikkim and North-eastern India, up to 1500 m, on wetlands.	Can be planted on wetlands and waterlogged soils. Seedcake suitable as cattle- and poultry-feed; may be used as fertilizer. Seed yields a fat (32–48%); can be used in soapmaking; also in confectionary and incense-making; applied for sprains.
Adina cordifolia (Roxb.) Hook. f. ex Brandis (*Rubiaceae*) (Beng & Assam–*Kelikadam;* Guj–*Haldarvo;* Hindi–*Haldu;* Mal & Tam–*Manjakadambu;* Mar–*Heddi;* Oriya–*Holondo;* Tel–*Pasupukadamba;* TRADE–*Haldu*).	Large, deciduous tree, up to 18 m.	Deciduous forests throughout the greater part of India; common in South India, especially in the eastern ghats and Karnataka.	Suitable to reclaim well-drained slopes, hills and alluvial soils; recommended for social forestry. Timber good for constructional and other works. Used in medicine. Yields very good firewood. Leaf used as fodder (crude protein, 15.3%).
Aerva persica (Burm. f.) Merrill syn.	Hoary-tomentose herb, up	Almost throughout India in arid	Suitable for the reclamation of

A: javanica (Burm.f.) Juss. ex Schult. (*Amaranthaceae*) (JAVANESE WOOL-PLANT; Guj–*Bur;* Kan–*Doddahindigidda;* Tam–*Perumpoolai;* Tel–*Magavira;* Delhi–*Dholi-mundi;* Punjab–*Boikalan;* Rajasthan–*Buida*).	to 1 m.	zones, on old alluvial sandy soils (rainfall 150–300 mm). Through seed.	eroded rocky surfaces and piedmont plains. Leaf given as fodder. Root used as toothbrush. Flowering-tops used for decoration and stuffing pillows.
A. pseudotomentosa Blatt. & Hallb.	Much-branched, densely woolly-tomentose herb, up to1.5 m.	Arid and semi-arid zones of Rajasthan on old alluvial sandy soil.	Reclamation of sand-dunes.
Aeschynomene americana Linn. (*Fabaceae*) (THE THORNLESS MIMOSA).	Short-lived, deep-rooted, perennial herb or shrub, up to 2 m.	Native to the West Indies and tropical America, naturalized in Hazaribagh and Ranchi Dist in Bihar. Through seed.	Used as a green cover-crop and manure. Fixes nitrogen.
A. aspera Linn., non Muehl. ex Willd. nec *sensu* Wall. (THE SOLAPITH PLANT; Beng–*Shola;* Hindi *Sola;* Kan–*Alaginagida;* Mal–*Kadessum;* Tam–*Attuneddi;* Tel–*Neerujeelugabendu*).	Tall, little-branched, aquatic herb, up to 3.6 m.	Assam, West Bengal, Bihar, Orissa and in the peninsular India, Himachal Pradesh and Uttar Pradesh. Through seed.	Can be grown for the reclamation of swampy areas and banks of tanks, rivers or lakes. May be used as fuel, for charcoal and fodder. Pith has high insulating properties and used for making bottle-corks, swimming-jackets, lifebelts, and paper.
Aesculus indica Hook. (*Sapindaceae*) (HIMALAYAN CHESTNUT, INDIAN HORSE-CHESTNUT; Hindi–*Bankhar;* Jaunsar–*Pu;* Kashmir–*Hanedun;* Kumaun–*Pangar;* Punjab–*Bankhor*).	Large, deciduous tree, up to 30 m/ 7.5 m.	From Kashmir to Nepal, at 900–3600 m. Prefers rich, moist, shady ravines. Coppices well and produces rootsuckers. Through seed, transplanting and rootsucker.	Recommended for reclamation of ravines, and agro- and social forestry. Timber largely used for buildings, packing-cases, etc. Shoot and leaf used as fodder; fruit also eaten by cattle,. Seed (protein, 5.85%) eaten during scarcity.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Agathis dammara Rich. syn. *A. alba* Foxworthy; *A. loranthifolia* Salisb. (*Araucariaceae*) (AMBOINA PITCH-TREE).	Tall, evergreen tree, up to 45 m/5.5 m. *Fr.*: Ripens in 2 years.	Cultivated in Calcutta gardens and elsewhere.	Suitable for afforestation of eroded soils. Yields a resin, DAMMAR or COPAL, used in paints, inks and lacquers.
Agrostis canina Linn., non Munro (*Poaceae*) (VELVET-BENT).	–	Kashmir.	Suitable as a soil-binder and soil-cover, and for permanent wet pastures. Used as fodder.
A. gigantea Roth (BLACK-BENT).	–	Himachal Pradesh.	– do –
A. stolonifera Linn. syn. *A. alba* auct., non Linn.; Hook. f. (Fl Br Ind) in part; *A. wightii* Nees ex Steud. in part; *A. verticillata* Hook. f. (Fl Br Ind) in part, non Vill. (CREEPING-BENT).	Tufted, glabrous perennial, up to 90 cm, with leafy, creeping stolons.	From Kashmir to Kumaun, Sikkim and Assam, up to 4000 m; also on the Nilgiris.	Recommended for calcareous metalliferous soils; forms close turf. Useful for alpine pastures, lawns, and golfcourses. Useful as fodder (crude protein, 8.29–10.82%) and may be cut for hay.
A. tenuis Sibth. (COMMON BENT).	Erect or spreading, slender, tufted perennial, up to 70 cm, with creeping rhizomes.	Introduced into Himachal Pradesh. Through seed and rhizome.	Mainly used for soil-conservation and for fine lawns; recommended for acid metalliferous soils, such as lead, zinc and copper wastes. Grown as pasture (crude protein, 13.34%); sometimes cut for hay.

A. inaequiglumis Griseb. from Sikkim, *A. micrantha* Steud. from Garhwal, Sikkim, and Assam, *A. munroana* Aitch. & Hemsl. from Kashmir to Kumaun, *A. nervosa* Nees ex Trin. from the eastern Himalayas and *A. subaristata* Aitch. & Hemsl. from Kashmir can also be used for pastures and turfs.

Alangium chinense (Lour.) Harms syn. *Stylidium chinense* Lour.; *Karangolum chinense* Kuntze; *Marlea begoniifolia* Roxb.; C. B. Clarke (Fl Br Ind) in part; *M. affinis* Decne; *M. chinensis* Druce; *Stylis chinense* Poir. (*Alangiaceae*) (Beng–*Bonipodo;* Assam–*Bhelu;* Garo–*Phagrany;* Jaunsar–*Bhutkainju;* H P & Punjab–*Budanar;* Kashmir–*Prot;* Khasi–*Dieng-mylliat-lap;* Kumaun–*Garh;* Lepcha–*Palit-kung*).	Small, moderately fast-growing tree.	From Kumaun to Arunachal Pradesh, Assam, Meghalaya, and Manipur, up to 2100 m; also found on the Madgol hills of Andhra Pradesh, up to 900 m; occasionally grown as a hedge.	Recommended for moist ravines. Timber used for furniture, handles, etc. Leaf lopped for fodder. Host for lac-insect.
A. salviifolium (Linn. f.) Wang. syn. *A. lamarckii* Thw.; *Grewia salviifolia* Linn. f. (Beng–*Akarkanta;* Guj & Hindi–*Ankol;* Kan–*Ankolimara;* Mal & Tel–*Ankolam;* Tam–*Alangi*).	Deciduous, rambling shrub or small tree, up to 10 m.	Plains and foothills throughout the greater part of India. Through seed and *gootee.*	Recommended for soils in the Deccan fallow- and wastelands. Timber good for musical instruments and furniture. Dried branches make a good hedge. Excellent firewood. Bark possesses hypotensive activity. Root given in blood-pressure; shows anthelmintic activity. Fruit eaten.
Aleurites fordii Hemsl. (*Euphorbiaceae*) (TUNGOIL TREE).	Much-branched deciduous, quick-growing tree, up to 8 m.	Native to China, introduced into India, mainly in tea-estate of Assam, West Bengal, Bihar, Karnataka and Kerala; also in Himachal Pradesh and Uttar Pradesh. Flourishes in rocky areas and on poor soils.	Suitable to grow on rocky and poor soils, and slightly acidic, well-drained soils for reclamation. Seedcake suitable for manure. Kernel yields an oil (49–65%); used for protective coating in artificial leather, brakelinings, etc. Bark (12%) and husk (4–5%) yield tannins.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Alhagi pseudalhagi (Bieb.) Desv. syn. *A. camelorum* Fisch. ex DC.; *A. maurorum* Medic. (*Fabaceae*) (CAMELTHORN; PERSIAN MANNA PLANT; Beng–*Dulallabha; jawasha;* Guj & Mar–*Jawasa;* Hindi–*Bharbharra, javasa;* Kan–*Billiduruva;* Tel–*Girikarimika, tellaginiyachettu;* Punjab–*Tamiya*).	Xerophytic, spiny shrub, up to 60 cm.	Found widely in Ganga valley and the arid tracts of Maharashtra, Gujarat, Rajasthan, Punjab, Kashmir and Bihar; also grows as a weed in fields. Through seed.	Can be grown for reclaiming rocky, gravelly soil and graded riverbed. Fixes nitrogen. Given as fodder (protein, 10.0–11.6%) for camels. Possesses anti-bilious and antiseptic, laxative, diuretic and expectorant properties. Contains tannins, flavonoids, ascorbic acid, mucilage and essential oil.
Alloteropsis cimicina (Linn.) Stapf syn. *Axonopus cimicinus* Beauv. (*Poaceae*) (CARPETGRASS; Beng–*Basantighas;* Kan–*Nirusajjai-hullu;* Mal–*Kodapullu;* Tel–*Borrapaalagaddi;* UP–*Suri*).	Annual grass, with ascending culms, up to 90 cm.	Fairly common throughout India in the plains and lower foothills up to 1500 m; withstands moderate drought and frost. Through slip.	Soil-binder; recommended for soil-conservation; suitable for planting along waterchannels and waterways. A good pasture at lower elevations, relished by cattle and goats; can be converted into hay.
Aloe barbadensis Mill. syn. *A. vera* Tourn. ex Linn.; *A. perfoliata* Linn. var. *vera* Linn.; *A.vulgaris* Lam.; *A. chinense* Baker; *A. indica* Royle; *A. abyssinica* Lam. (*Liliaceae*) (INDIAN ALOE; Beng & Sans–*Ghritakumari;* Guj–*Kunawar;* Hindi–*Ghee-kanwar;* Kan–*Maulisara;* Mal–*Kattavazha;* Mar–*Korphad;* Oriya–*Kumari;* Tam–*Kottaalai;* Tel–*Kalabanda*).	Coarse-looking perennial plant, with a short stem, and very thick leaves.	Introduced into India, naturalized almost in all parts of the country; found on well-drained soils, consisting of broken brick and coarse sand, and even on the poorest soils; flourishes in a variety of climate. Withstands drought. Through seed, sucker and cutting.	Because of the stiff, harsh and rugged habit suitable for growing in deserts and other dry situations. Leaf and flower-stalk are pickled. Leaf yields a fibre. Useful in many diseases.

Alstonia scholaris R. Br. (*Apocynaceae*) (DEVIL'S TREE; DITA-BARK TREE; Beng & Hindi–*Chatwan;* Kan–*Jantaalamara;* Mal & Tam–*Ezhilippalai;* Mar–*Saptaparni, stawin;* Oriya–*Soptorposi;* Tel–*Aedakularitehttu, Paalaagaruda;* TRADE–*Chatianwood*).	Large, evergreen, tree, up to 27 m/ up to 2. 4 m.	From the western Himalayas through the sub-Himalayan tract, in eastern India, on the west coast and other moist parts; and in the Andamans. Planted for ornament and as avenue-tree. Found in a variety of climates. Through seed.	Can be grown to reclaim skeletal soils, rocky soils, saline and alkaline soils and mined sites. Recommended for social forestry. Timber used for packing-cases, tea-boxes, plywood-boards, match-splints, etc. Bark yields a fibre. Bark, leaf and latex possess medicinal properties.
Altingia excelsa Noronha (*Altingiaceae*) [Resin, Guj, Hindi & Mar–*Silaras;* Mal–*Rasamala;* Tam–*Neriyurishippal;* Tel–*Silarasmu;* Assam–*Duang* (tree)].	Aromatic tree, up to 30 m/ up to 5 m.	Arunachal Pradesh and Assam. A light-demander. Through seed and transplanting.	Suitable for afforestation of eroded land. Timber useful for bridges and buildings, wagons and sleepers. Yields a bitter, pungent, carminative, expectorant, stomachic, and antipyretic resin; used in leucoderma, scabies, lumbago, urinary diseases.
Amaranthus spinosus Linn. (*Amaranthaceae*) (SPINY AMARANTH, SPINY PIGWEED; Beng–*Kantamaris;* Guj–*Kantalo dhimdo;* Hindi–*Kantabhaji, katailichaulai;* Kan–*Mulladantu;* Mal–*Mullancheera;* Mar–*Kantebhaji;* Oriya–*Kantaneutia;* Tam–*Mullukeerai;* Tel–*Mundltootakoora*).	Erect, spinous annual or perennial herb, varying in colour from green to purple, up to 1 m.	Native to tropical America, found throughout India. Drought-resistant. Through seed.	Found as a luxuriant weed in cultivated as well as fallow-land and many waste places; evergreen even in deserts. May be useful for reclamation. Used as potherb; wholesome and agreeable.
A. viridis Linn. syn. *A. gracilis* Desf. (GREEN OR WILD AMARANTH,	Annual herb, up to 60 cm.	Throughout India. Through seed.	Very commonly grows on wastelands; may be grown for

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
GREEN PIGWED; Beng–*Bannote;* Guj–*Dhinmado;* Kan–*Chilikirae-soppu;* Mar–*Lhanamat;* Tam–*Kuppaikeerai;* Tel–*Chilakatootakoora*).			reclamation. Good fodder. Excellent potherb and tastes like spinach when boiled. Leaf applied to inflammations, boils and abscesses; yields tannins. Ash used in making soap.
Ammannia baccifera Linn. syn. *A. salicifolia* Hiern; C. B. Clarke (Fl Br Ind)in part, non Monti ex Blume (*Lythraceae*) (BLISTERING AMMANNIA; Beng & Hindi–*Dadmari;* Guj–*Jala agio;* Mal–*Kulluravanchi;* Mar–*Bharjambhul;* Tam–*Kallurivi;* Tel–*Agnivedanapaaku*).	Glabrous, erect, branching herb.	Throughout India, in tropics and warm-temperate regions; found as a weed in paddy-fields and marshy localities. Through seed.	Reclamation of marshy places. Leaf (vitamin-C, 88.9 mg/100 g) acrid and used in the treatment of rheumatic pains and fevers; also used as stomachic and laxative; fresh, bruised leaves used for ringworm.
**Anthocephalus chinensis* (Lam.). A. Rich. ex Walp. syn. *A. cadamba* (Roxb.) Miq.; *A. indicus* A. Rich. (*Rubiaceae*) (WILD CINCHONA; Beng–*Bolkadam;* Guj, Hindi, Mar & Sans–*Kadambam;* Kan–*Kadawala;* Mal–*Attutek, kodavara;* Oriya–*Kadambo;* Tam–*Kolaoyila;* Tel–*Kadambamuchettu;* Assam–*Roglu;* TRADE–*Kadam*).	Fast-growing, occasionally buttressed tree, up to 37.5 m/up to 2.4 m.	Moist, warm type of deciduous and evergreen forests; sub-Himalayan tracts from Nepal to Darjiling, Bihar, Orissa, Andhra Pradesh, Karnataka, Kerala and the Andamans with a rainfall of 150–500 cm. Plentiful in old abandoned areas and in old *taungyas*. Also cultivated for ornament. A light-demander. Coppices well. Through seed, transplanting and cutting.	Can be grown on abandoned lands, grassy blanks and other waste-lands. Recommended for agro- and social forestry. Timber used for boards, plywood, packing-cases, etc. Good firewood. Leaves lopped for fodder. (crude protien, 21.3%). Fruit eaten raw or cooked.

* Some combine it with *Platanocephalus* Crantz.

Anthoxanthum odoratum Linn. (*Poaceae*) (SWEET VERNAL GRASS).	Polymorphic, aromatic, tufted perennial, up to 100 cm.	Introduced into Himachal Pradesh, Uttar Pradesh, Meghalaya and on the hills of South India; ran wild at several places.	Suitable for zinc-rich soils. Sheep graze upon it (crude protein 11.3%). Yields an essential oil called FLOUVE OIL, used in perfumery.
Areca catechu Linn. (*Arecaceae*) [ARECANUT, ARECAPALM, BETEL NUT-PALM; Beng, Hindi, Mar & Punjab–*Supari;* Guj–*Sopari*; Kan–*Adike;* Mal–*Adakkamarom;* Tam–*Paakkumarom;* Tel–*Gautupooka, kolapooka* (palm); *vakka* (nut)].	Tree, with annulate stem, up to 30 m.	Coastal region from Maharashtra to Kerala and Tamil Nadu; the Deccan Plateau; Assam, Meghalaya, West Bengal, up to 1000 m and in the Andaman and Nicobar Islands. Extensively cultivated in Karnataka, Kerala, and Assam and to a less extent in Gujarat, Orissa, and Tripura. Thrives on a variety of soils, such as laterite soils, red loamy soils, loam and alluvial, soils with lime, ill-drained saline and alkaline soil with *kankar* nodules. Shadeloving, sensitive to drought, and waterlogging.	Suitable to reclaim the soils mentioned; recommended for agroforestry. Nut extensively used as masticatory either alone or with betel-leaves; good source of flouride. Aqueous extract possesses antibacterial properties. Yields tannins (8–18%). Husk used for fine-quality hard-boards, etc.
Argemone mexicana Linn. (*Papaveraceae*) (MEXICAN POPPY, PRICKLY POPPY; Beng–*Shialkanta;* Guj–*Darudi;* Hindi, Mal, Sans & Tel–*Brahmadandi;* Kan–*Datturigidda;* Mar–*Pivla-dhotra;* Oriya–*Kanta-kusham;* Tam–*Kurukhum;* Mundari–*Bakulajanum;* Punjab–*Bhatketeya;* Santal–*Gokhulajanum*).	Erect, prickly annual herb, up to 1.2 m.	Naturalized as a weed throughout India. Through seed.	Very common weed in agricultural and wastelands. Suitable for the reclamation of alkaline soils. Dried and powdered plant can be applied as green manure to alkaline soils, as it has high content of N, Ca, P & K. Oilcake can be used as manure. Seed used for diarrhoea and

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
			dysentery; yields an inedible ARGEMONE OIL. Useful as an illuminant, lubricant, in soap-making and for protection from white ants.
Artemisia spp (*Asteraceae*) (SAGEBRUSH or WORMWOOD).	Small herbs or shrubs, with much-divided leaves.	Common almost throughout India. Through seed and cutting.	Xerophytes and grow in extremes of temperature; can be cultivated on semi-arid, saline, sandy soils and cold deserts. Some species useful as fodder. Aromatic, bitter plants; some are a valuable source of anthelmintic drug santonin. Several species yield essential oils (0.12–1.68%).
Arthraxon lancifolius Hochst. syn. *A. microphyllus* Hochst.; Hook. f. (Fl Br Ind) in part (*Poaceae*).	Delicately diffuse, leafy annual, up to 3 cm. *Fl. & Fr.*: July–October.	Found almost throughout India, up to *c* 3300 m in the Himalayas; very common on old walls, eroded surfaces and waste places.	Often found gregariously growing as a pioneer on soil that has been exposed by slips in the hills. Used as fodder (protein, 3.86%).
A. quartinianus (A. Rich.) Nash	Annual grass.	Peninsular India; found in swampy areas and by roadside.	Pioneer on abandoned lands. Eaten by cattle.
Arthrocnemum indicum Moq. syn. *A. glaucum* Woodr., non Ung.-Sternb. (*Chenopodiaceae*) (Beng–*Jadu-palang;* Guj–*Bholado;* Hindi–*Machola;* Bombay & Mar–*Machur;* Tel–*Koyyapippallu*).	Glaucous-green, fleshy, suffruticose, perennial, mangrove herb.	West Bengal, Andhra Pradesh, Gujarat, Tamil Nadu and Maharashtra. Through seed.	Can be grown in saline soils to reduce salinity. Eaten as salad and also pickled. Ashes used as a mordant in dyeing.

Arthrophyllum diversifolium Blume (*Araliaceae*).	Tree, up to 12 m.	Andaman and Nicobar Islands.	Grown for afforestation; also as hedge.
Artocarpus heterophyllus Lam. syn. *A. integrifolia* Hook. f. (Fl Br Ind) in part, non Linn. f.; *A. integrifolia* Linn. f. var. *heterophylla* Pers.; *A. integra* auct., non Merrill (*Moraceae*) (JACKFRUIT, JACKTREE; Beng–*Kanthal;* Guj & Mar–*Phanas;* Hindi & Assam–*Kathal;* Kan–*Halasu;* Mal–*Pilavu;* Oriya–*Ponoso;* Tam–*Murasabalam;* Tel–*Panasa;* Khasi–*Dieng-soh-phaw*).	Large, evergreen tree, up to 15 m. *Fl. & Fr.:* March–September.	Indigenous to evergreen forests at 450–1200 m. Wild in Andhra Pradesh; common in Kerala. Cultivated throughout the hotter parts of India. Tolerates a variety of soils. Coppices well. Through seed.	Can be grown on a wide variety of soils including island-region. Recommended for agro- and social forestry. Timber used for carpentry, boxes, furnitures, musical instruments, etc. Leaf lopped for fodder. Bark yield tannins. Fruit popularly called poorman's food, used in a variety of culinary preparations. Seed starchy and eaten.
A. lakoocha Roxb. (MONKEY-JACK; Beng–*Dahu;* Guj–*Lakoocha;* Hindi–*Barhal;* Kan–*Esuluhuli;* Mal–*Kattupilavu;* Mar–*Wotomba;* Oriya–*Jeuto;* Tam–*Irapala;* Tel–*Kommaregu;* TRADE–*Barhal*).	Large, deciduous tree, up to 20 m. *Fl. & Fr.:* January–February & October–November; April–May & January–February.	Eastern and western India, Konkan southwards to Kerala, up to 1800 m and in Tamil Nadu; and the Andamans. Cultivated.	Can be grown along banks of stream, moist ravines and laterite soils, for afforestation and preventing erosion. Recommended for social forestry. Timber used in house construction. Leaf used as fodder. Bark substituted for betelnut; yields a fibre for cordage. Ripe fruit edible; used in many preparations.
Arundinella nepalensis Trin. syn. *A. brasiliensis* Hook. f. (Fl Br Ind) in part, non Raddi; *A. setosa* Trin. (*Poaceae*) (Hindi–*Murkiapuleri;* Kan–*Hakkivargihullu;* Tel–*Pathioopagaddi*).	Perennial Grass.	Hilly parts throughout India, up to 2000 m. Through cutting.	Suitable for cultivation on alkaline and saline soils. Cattle graze upon it (protein, 7.0%). Used for making brooms.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Arundo donax Linn. (*Poaceae*) (DANUBIAN, GIANT, SPANISH BAMBOOREED; Beng–*Gahanal;* Hindi–*Baranal;* Tam–*Korukkai;* Tel–*Adavikeekasagaddi;* Assam–*Gabanal;* Delhi–*Narhal;* Garhwal–*Naldura;* Punjab–*Bansi;* U P–*Narkul*).	Tall, robust, erect, cane-like, branched perennial up to 8 m, with shallow culms.	Lower Himalayas, up to 2000 m. Kashmir to eastern India extending southwards into peninsular India, occurring wild or cultivated near water; cultivated for ornament. Through cutting and rhizome.	Sand-loving and can be grown for stream-bank control; used to prevent-erosion along watercourses and edges of hills and to stabilize drifting sands; useful for water-logged areas and recommended for social forestry. Grown as windbreaks, hedges, as support for various plants; also used for fences and trellises. Cattle graze upon it (soft leaf: crude protein, 13.2%; whole-plant hay: crude protein, 8.8%). Alone or in combination with sabai grass, used for making paper for writing, wrapping and printing, and for rayon-pulp. Employed for wicker-work. Rhizome used in dropsy.
Atriplex halimoides Tineo (*Chenopodiaceae*).	Dwarf bush.	Introduced into India from Australia.	Suitable for reclaiming the saline tracts; best pasture on them.
A. halimus Linn. (MEDITERRANEAN SALTBUSH, SEA-ORACHE).	Much-branched, woody herb, up to 3 m.	Introduced from Israel; found to grow well in Jodhpur and Pali in Rajasthan.	Valuable for the reclamation of arid and semi-arid areas. Valued as fodder (protein, 2.6%). Ash from the plant is used in manufacturing soap.

A. hortensis Linn. (MOUNTAIN-SPINACH; Beng, Hindi & Assam–*Pahari-palang;* Kan–*Chakottaesoppu;* Mar–*Chandanbatva;* Punjab–*Korake*).	Erect, succulent annual herb, with striate, glabrous stems, often tinged with red or purple.	Temperate western Himalayas, up to 3650 m, Assam and Meghalaya; cultivated almost throughout India. Drought-resistant. Tolerates salinity and alkalinity.	Suitable for dry areas and alkaline and saline soils. Cultivated and used like spinach. Rich in protein (31.3%). Seed-flour helpful in vitamin-A deficiency. Also contain a saponin.
A. nummularia Lindl. (OLDMAN SALTBUSH).	Bushy, tomentose, perennial shrub, with spreading branches.	Introduced into India from Israel. Highly drought-resistant.	Suitable for reclamation of dry, sandy and alkaline soil near the seacoast or in the arid regions; primary colonizer on the nickel-rich wastes; provides wind-shelter. Most useful fodder; green leaves highly nutritive.
A. patula Linn.			Recommended for cultivation on wastelands.
Atylosia scarabaeoides Benth. (*Fabaceae*) (Beng–*Banurkalai;* Oriya–*Bankulthia;* Kol–*Gaisani;* MP–*Jangli tur;* Mundari & Santal–*Birhore;* Oraon–*Kandoarsga*).	Slender twines, with densely grey-downy stem. *Fl.:* Almost throughout the year.	Throughout India; common in hedges, grassy areas, scrub-jungles and in somewhat open forests on clayey soil; grows well as rain-fed crop. Drought-resistant. Through seed.	Can be used as soil-cover and fodder. Useful as green manure. Fixes nitrogen. Leaf and pod eaten as potherb. Seed also eaten and used as a remedy against tapeworm.
Avicennia marina Vierh. (*Avicenniaceae*) (Tam–*Vankadan;* Tel–*Mada*).	Shrub or small tree.	Along the coast and in tidal water and salt-swamps.	Useful for reclamation of estuarine areas. Timber used for boat-building. Bark used for tanning (12.5%).
A. officinalis Linn. (WHITE MANGROVE;	Shrub or small tree.	Throughout India and in the	Useful for the reclamation of

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Beng–*Baen*; Guj–*Tavariyan*; Hindi–*Bani*; Kan–*Ipati*; Mal–*Oepata*; Mar–*Tivar*; Tam–*Uppattam*; Tel–*Erivogu*).		Andamans; found in salt-marshes and tidal creeks along the coasts.	estuarine areas. Used for fuel and fodder (crude protein, 12.3%).
Axonopus compressus (Sw.) Beauv. (*Poaceae*) (CARPETGRASS).	Stoloniferous, perennial grass, up to 60 cm, with short stolons forming dense turf.	Native to tropical America, introduced and naturalized as a pasture in Assam, West Bengal, Uttar Pradesh and Karnataka. Grows well in partial shade and withstands temporary flooding and close grazing or cutting and trampling. Through seed, root-slip and set.	Can be grown on variety of soils, especially in soils rich in organic matter. Useful for controlling soil-erosion in plantations of cinchona and rubber; grown as firebreaks. Also used as turf for lawns (protein, 1.8%). Produces abundant seeds even when heavily grazed. Contains vitamin-A, -B and -C.
Barleria acanthoides Vahl (*Acanthaceae*) (Rajasthan–*Bajardanti*).	Woody, prickly, branched undershurb, up to 30 cm.	North-West India, in mixed xeromphic thorny forest; requires a rainfall of 300–700 mm.	Grows on rocks and gravelly soils; may be useful for reclamation. Given as fodder for camels and goats.
**Blepharis sindica* Stocks ex T. Anders. (*Acanthaceae*) (Guj–*Sindhiutigana*; Bombay–*Jasad*; Rajasthan–*Bhan-gari*).	Small, woody annual.	Punjab, Haryana, Rajasthan and Gujarat; found in mixed xeromphic thorny forest; requires a rainfall of 150–250 mm.	May be useful for reclamation of dry areas. Given as fodder for sheep, goats and other cattle to increase milk. Seed boiled in milk and taken as tonic; plant or seed used as a cure for earache.

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* Some consider it to be a synomyn of *B. linariifolia* Pers.

**Boerhavia diffusa* Linn. syn. *B. repens* Linn. (*Nyctaginaceae*) (SPREADING HOGWEED; Beng–*Punarnaba;* Guj–*Satodi;* Hindi–*Sant;* Kan–*Balavadikae;* Mal–*Titudamma, tumizhazhma;* Mar–*Raktavasu;* Oriya–*Ghodapuruni;* Tam–*Mukkurattaikeerai;* Tel–*Giligeru, yerragiligeru;* Mundari–*Khapra;* Punjab–*Itsit;* Santal–*Khaprashak*).	Diffusely branched, pubescent or glabrous, postrate variable herb.	Throughout India, up to 2000 m; a common weed on grasslands, cultivated fields and orchards; also cultivated in West Bengal; found on gravelly soils in mixed xeromphic thorny forest; requires rainfall of 350–750 mm. Through seed.	Useful lithophyte for eroded rocky surfaces. Relished by sheep and goats and given to milch cows to increase milk. Eaten as a vegetable in curries and soups. Plant yields the drug *Punarnava* which possesses diuretic and anti-inflammatory activities; root credited with anticonvulsant, analgesic, laxative, diuretic and expectorant properties.
B. erecta Linn. syn. *B. punarnava* Saha. & Krishn.	–	Native to tropical America, naturalized in upper Gangetic plains, Maharashtra, Pondicherry, and Kerala.	Grows on waste places and roadsides; may be useful for reclamation. Cooked and eaten.
Bonamia latifolia (Hochst. & Steud.) Sant. (*Convolvulaceae*).	–	Arid zones of Rajasthan. Grows on gravelly soils.	Useful lithophyte, found on eroded rocky surfaces and piedmont plains; may be grown on such soils for reclamation.
Bougainvillea spp (*Nyctaginaceae*) (BOUGAINVILLEA).	Shrubs, vines or small trees; usually armed with spines. *Fl. & Fr.:* January–October.	Native to tropical and subtropical South America; cultivated in India for ornament. Through cutting, layering and budding.	Can be raised on various wastelands; recommended for social forestry with a high yield of renewable source of energy. Pyrolysis helps in storage, handling, transportaion and in smokeless-burning.

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* Some consider them to be separate.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Bouteloua gracilis Lag. ex Steud. (*Poaceae*) (BLUE GRAMAGRASS).	Densely tufted, rhizomatous perennial, up to 50 cm.	Introduced into India, thrives in pastures. Fairly drought-resistant.	Useful for soil-conservation. Grown for forage (crude protein, 4.2–12.7%) and hay (crude protein, 4.2–11.3%); good source of vitamin-A.
Bridelia airy-shawaii Li syn. *B. retusa* (Linn.) Spreng. (*Euphorbiaceae*) (Beng–*Geio;* Guj, Mar & Sans–*Asana;* Hindi–*Ekdania;* Kan–*Goje;* Mal & Tam–*Mulluvaengai;* Oriya–*Kosi;* Tel–*Korramaddi;* Assam–*Kohir;* Khasi–*Dieng-risham;* TRADE–*Kasi*).	Fast-growing shrub or tree, up to 18 m, with strong conical spine.	Throughout India, up to 1000 m; abundant in deciduous forests. A common associate of *sal*, but never gregarious. Withstands moderate shade; coppice well. Through seed and rootsucker.	Recommended for agro-forestry; also for wet areas. Timber a recommended substitute for *sal* and teak for building constructions, etc. Leaf (crude protein, 11.6%) good cattle-feed. Bark yields tannins (16–40%); a valuable astringent. Fruit edible.
Bromus inermis Leyss. (*Poaceae*) (SMOOTH BROMEGRASS).	Stoloniferous, perennial, up to 1.2 m.	From Kashmir to Kumaun, at 1500-3900 m. Highly drought- and winter-hardy.	Suitable to reclaim mine-spoils. Grass (crude protein, 13.6%) highly palatable; makes good hay; silage increases milk; rich source of vitamins. Useful in grass–legume mixtures.
B. tectorum Linn. (DROOPING BROMEGRASS)	Erect annual, up to 60 cm. *Fl. & Fr.:* June–July.	From Kashmir to Kumaun and Arunachal Pradesh, at 2100–3300 m; on walls, roofs and waste places.	Gregariously grows in waste places and deserts and useful for reclothing. Palatable and nutritious (crude protein, 15.8%).
B. unioloides H.B.&K. syn. *B. cathar-*	Tall, annual grass, with	Native to America, introduced into	Good sand-binder; recommended

ticus Vahl (PRAIRIE- GRASS).	tufted culms.	India. Withstands drought fairly well.	for reclamation of cold deserts. Most nutritious fodder (crude protein, 7.0–13.6%). Possesses purgative properties.
Bruguiera cylindrica (Linn.) Blume syn. *B. caryophylloides* Blume; Hensl. (Fl Br Ind) in part; *B. malabarica* Arn. (*Rhizophoraceae*) (Tam–*Kakandan;* Tel–*Vurada*).	Small, buttressed tree, up to 23 m.	Tidal forests of eastern and western India.	Recommended for growing on estuarine coastal wastelands. Timber used as fuel. Bark (up to 35%) and leaf yield tannins. Young radicles eaten or pickled.
B. gymnorrhiza (Linn.)SAVIGNY syn. *B. eriopetala* Hensl. (Fl Br Ind) in part; *B. conjugata* Merrill (Beng–*Kankara;* Oriya–*Kekar;* Tam–*Sigapukokandam;* Tel–*Thuddaponna*).	Large, evergreen, buttressed tree, up to 36 cm.	Estuarine forests of India; also in the Andamans.	Recommended for reclaiming estuarine areas. Timber used as fuel and for charcoal; also used for houses, posts, beams, doorframes. A valuable tanniferous mangrove. Bark yields tannins (25–65%). Stem and branches used for thatching. Seed edible.
B. parviflora Wight & Arn. ex Griff.	Tree, up to 25 m.	Found in salt-marshes of Maharashtra, Karnataka, Kerala, Andhra Pradesh, Orissa, West Bengal, and in the Andamans.	Recommended to reclaim estuarine coastal wastelands. Timber used as fuel. Bark (5.5–9.6%) and leaf (12%) contain tannins. Germinating embryo eaten.
B. sexangula Poir. syn. *B. eriopetala* Wight & Arn. ex Arn.; Hemsl. (Fl Br Ind) in part (Oriya–*Kekara*).	Tree, up to 33 m, with kneed roots.	Kerala, Tamil Nadu, Andhra Pradesh and Orissa.	Recommended for reclaiming estuarine coastal wastelands. Germinating embryo eaten.

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Species/Family/Names	Characters	Distribution/Propagation	Utilization
Buchloë dactyloides (Nutt.) Engelm. (*Poaceae*) (BUFFALOGRASS).	Deep-rooted, stoloniferous grass, up to 20 cm.	Native to Central America, introduced into the Nilgiris. Drought-resistant. Through seed and rootslip.	Makes an excellent cover for exposed dry banks and forms a soft greyish-green dense turf; useful for controlling soil-erosion. Nutritious fodder (protein, 3.6–6.8%); withstands severe and prolonged grazing.
Buddleja asiatica Lour. syn. *B. neemda* Buch.-Ham. (*Buddlejaceae*) (WHITE BUTTER-FLYBUSH; Hindi–*Neemda;* Assam–*Agiachita;* Khasi–*Dieng-tuti-myneng;* H P–*Newarpati;* Kumaun–*Bhati;* Lepcha–*Pondon*).	Evergreen, undershrub or shrub, up to 1.8 m.	Throughout India, up to 2400 m; also grown as an ornamental hedge.	Suitable for mine-wastelands; also recommended for growing on landslips. Flower eaten after cooking.
Bulbostylis barbata (Rottb.) C. B. Clarke syn. *Scirpus barbatus* Rottb. (*Cyperaceae*) (Hindi–*Masa;* Kan–*Chavurihullu;* Tam–*Mukkutikorei;* Delhi–*Musadadhi*).	Densely tufted sedge, up to 25 cm.	Throughout India, up to 1200 m.	Suitable for planting on oilmine-workings. Indicates high concentration of zinc. Decoction given in dysentery.
Caesalpinia bonduc Roxb. emend Dandy & Exell.; Baker (Fl Br Ind) in part syn. *C. bonducella* (Linn.) Flem.; *C. jayabo β cyanosperma* Maza; *Bonduc minus* Medic. (*Caesalpiniaceae*) (FEVERNUT, BONDUCNUT; Beng–*Nata;* Hindi–*Karanju;* Kan–*Gajagakai;* Mal–*Kazanchikkuru;* Mar–*Gajaga*; Tam–*Gujju;* Tel–*Gachakaaya*).	Large, scandent shrub or climber, up to 15 m. *Fl. & Fr.:* August–October; October–February.	Wild throughout the plains of India, up to 1000 m. Grows in the open along canals, seacoasts and other open lands, particularly along the seacoasts and deltaic region. Through seed.	Recommended for growing along seacoast, canals, etc. and for shelterbelts in controlling sand-drift. Leaf (crude protein, 25.2%) given to bufalloes. Bark, stem, root and seed possess medicinal properties.

C. crista Linn. syn. *C. nuga* Ait.; Baker (Fl Br Ind) in part (Beng–*Netu;* Mal–*Kaakamullu*).	Large, woody climber, up to 15 m.	Found growing on river-banks in tidal forests in Orissa, western seacoast and Sundarbans.	Recommended for controlling soil-erosion in estuaries or tidal areas. Fixes nitrogen. Piscicidal.
C. digyna Rottl. (TERI-POD; Beng–*Amulkochi;* Hindi & Mar–*Vakerimul;* Oriya–*Gilo;* Tel–*Noonegachakaaya*).	Large, prickly scandent shrub or climber, up to 10 m.	Wild in Arunachal Pradesh, Assam, West Bengal, Madhya Pradesh and Andhra Pradesh and in the Andamans.	Can be grown on wastelands for afforestation. Seed (protein, 14.8%) used as cattle-feed. Fruit-shell (53.8–58.9%) rich in tannins. Root astringent, antipyretic.
Many species of *Caesalpinia* are grown as hedges and in rocky areas for afforestation; some fix nitrogen.			
Canavalia maritima (Aubl.) Thou. syn. *C. obtusifolia* DC.; Baker (Fl Br Ind) in part; *C. rosea* DC. (*Fabaceae*).	Shrub, trailing or occasionally climbing.	South India; found on sandy shores.	Useful sand-binder and covercrop particularly the mined sands. Fixes nitrogen. Also can be grown on roadsides or lakeshores.
C. ensiformis Linn. also fixes nitrogen.			
Capparis decidua (Forsk.) Pax syn. *C. aphylla* Roth (*Capparidaceae*) (Guj & Mar–*Ker;* Hindi–*Karer;* Kan–*Chippuri;* Tam–*Sengam;* Tel–*Kariramu;* Punjab–*Karil*).	Densely branching shrub or a small tree.	Dry areas of Punjab, Rajasthan, extending into dry areas of peninsular India. Grows on semi-rocky or rocky sites, mineral soils, piedmont plains of Rajasthan. Through seed and cutting.	Recommended for the arid and semi-arid regions, sand-dunes, eroded rocky lands, gullies and ravines and brackish-water areas. Suitable for soils with high *p*H and old alluvial sandy soils. Has high tolerance to salinity and alkalinity. Grown as hedges and windbreaks. Timber used for tool-handles, cart-wheels, ploughs, etc.; used as fuel. Young twigs serve as fodder for cattle and goats.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
			Tender shoots chewed to relieve toothache. Bark acrid, laxative, diaphoretic, anthelmintic and useful for cough, asthma and inflammations. Flower-bud and fruit edible and pickled; astringent; useful in cardiac troubles and biliousness.
*_C. spinosa_ Linn. (THE CASPERBUSH; Guj–_Kantharo; Hindi–Kalira;_ Kan–_Mullukattari;_ Tel–_Kokilaa-kshamu;_ Punjab–_Barar_).	Prostrate, glabrescent, polymorphic, spiny shrub or climber, up to 1.5 m.	Found on rocky and hilly localities in Punjab, Rajasthan and Deccan Peninsula.	Can be grown to reclaim dry, rocky and stony areas. Leaf (protein, 13.8%) and fruit relished by sheep and goats. Leaf used in curries; also used as poultice in gout. Bark bitter aperient, diuretic, expectorant and tonic. Bud and fruit used for pickling.
Carallia brachiata (Lour.) Merrill syn. _C. integerrima_ DC.; _C. lanceaefolia_ Roxb.; _C. lucida_ Roxb. (_Rhizophoraceae_) (Beng & Hindi–_Kierpa;_ Kan–_Andamurgl;_ Mal–_Varanga;_ Mar–_Shengali;_ Tel–_Karalli;_ Andamans–_Mania-wya;_ Assam–_Thekeramahi, kant-hekera;_ TRADE–_Caralliawood_).	Moderate-sized to large, evergreen tree, up to 33 m/ up to 2 m. _Fl._ & _Fr.:_ December–March; May–June.	Almost throughout India, up to 1300 m, and in the tidal creeks of the Andamans. Grows in evergreen and swamp forests along streams. Prefers moist deep soils. A shade-bearer. Somewhat frost-tender. Coppices well. Produces suckers. Through seed, transplanting, rootsuckers and rooted branch-cutting.	Can be grown to reclaim estuarine areas. Timber used for house-building, furniture, agricultural implements, etc. Leaf used for fodder. Bark (up to 20%) yields tannins. Fruit and seed edible; used for a tea-like beverage. Seed yields an edible oil, used as a substitute for _ghee._

* Probably comprises several varieties.

Carissa carandus Linn.; Hook.f. (Fl Br Ind) in part (*Apocynaceae*), (KARAUNDA; Beng, Guj, Hindi & Mar–*Karaunda;* Kan–*Karekai;* Mal–*Karakka;* Sans–*Karamarda;* Tam–*Karaikkay;* Tel–*Vaakkaya*).	Shrub or small crooked tree, up to 3 m, with 4 cm. long thorns.	Throughout India; frequently cultivated for fruit.	Recommended for agroforestry; useful for hedges. Timber used for combs, spoons and turnery; burnt as fuel. Fruit edible.
C. spinarum Linn.; Hook.f. (Fl Br Ind) in part (Hindi–*Karaunda;* Oriya–*Anka;* Tam–*Chiru;* Tel–*Kalivi;* Kashmir–*Garunda;* Punjab–*Jangli karunda*).	Bushy, evergreen shrub or rarely tree, up to 6 m, with 5 cm long thorns.	Throughout the hotter parts of India and the sub-Himalayan region, up to 1200 m, and in the Andamans; cultivated in gardens for fragrant flowers and edible berries. Common in dry, rocky places. Coppices well and produces suckers. Through seed and rootsucker.	Can be grown for clothing poor soils, dry and rocky places. Though heavily browsed withstands damage. Leaf browsed by sheep and goats. Leaf and fruit yield tannins (7.5%). Fruit eaten raw; makes good syrup and jellies.

Other *Carissa* spp also thrive under semi-arid conditions. They may be useful for reclamation of such areas.

Celtis australis Linn. (*Ulmaceae*) (EUROPEAN NETTLE-TREE; Assam–*Mohita;* Cachar–*Bonridu;* Kashmir–*Brimij;* Khasi–*Dieng-soh-thang-chi;* Punjab–*Batkar;* TRADE–*Nettle-wood, Celtis*).	Deciduous tree, up to 24 m/ up to 2 m.	From Jammu & Kashmir to Arunachal Pradesh, at 1650–2700 m. Not very exacting in soil-requirements. Grows on swampy, dry and rocky ground. Commonly planted for shade and fodder. Coppices and pollards well. Through seed and stump-planting.	Suitable for agro- and social forestry and for field-boundaries. Timber used for tool-handles, cups and spoons, sport-goods, agricultural implements, construction, etc. A medium firewood (4739 kcal/kg). Leaf lopped for fodder (crude protein, 11.99–15.54%). Fruit edible.
C. laevigata Willd. (SUGARBERRY, MISSISSIPPI HACKBERRY).	Tree, up to 30 m.	Introduced into India from America.	Recommended for cultivation on wastelands, particularly mined sites.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Centrosema pubescens Benth. (*Fabaceae*).	Slender, climbing perennial.	Native to tropical South America, introduced into India; found on lateritic and red loams and hilly regions up to 2000 m. Through seed.	Useful for soil-conservation and for green-manure, particularly useful for hills; ideal covercrop for new clearings in rubber, coffee, coconut and oilpalm estates. Grows like a carpet and lives on from year to year. Fixes nitrogen. One of the best fodders (crude protein, 15.5%); can be combined with grasses; withstands cuttings.
Ceratonia siliqua Linn. (*Caesalpiniaceae*) (CAROBTREE, LOCUSTBEAN; Bombay-*Meccaniamli;* Punjab–*Kharnub*).	Deciduous tree, up to 17 m.	Native to Mediterranean and southern Europe, introduced into India, naturalized in Punjab and a few other regions; cultivated on large scale in Karnataka. A light-demander. Through seed and cutting.	Suitable to grow on dry, stony, infertile or calcareous soil. Cultivated for shade and edible pods. Suitable for dry-farming Cannot fix nitrogen. Timber used for carts, agricultural implements; yields a dye, algarrobin. Potential tree for energy on farms. Pod rich in sugar (40–50%) and seed in protein; yields good forage. Bark yields tannins (up to 50%). Pod eaten in various forms. Yields beverages. Used in the treatment of cough. Seedflour (crude protein, 33.74–48.31%) edible and highly nutritious, and biscuits, bread and rusks are made; suitable for diabetic patients. Seed yields a

			gum, used for binding in foods; also used in stomach problems. As a stabilizer and thickner, used in cosmetic industry and as drilling-muds.
Chenopodium album **Linn.** (*Chenopodiaceae*) (LAMB'S QUARTERS; Beng–*Chandanbetu;* Guj–*Cheel;* Hindi, M P, Punjab & Rajasthan–*Bathuasag;* Kan–*Huchuchak-kotha;* Mar–*Chakvat;* Tam–*Parappukeerai;* Tel–*Pappukoora*).	Polymorphous, odourless, erect, annual herb, up to 3.5 m.	Common weed found wild and cultivated throughout India, up to 4200 m; grows on all types of well-drained soils, particularly on alluvial soil. Through seed.	Recommended for the estuarine areas and saline and alkaline soils; indicator of magnesium. Used as a potherb, and fodder; rich in vitamin-C and potassium. Seed cooked like rice and consumed. Plant laxative, anthelmintic and cardiotonic.
Chrysothamnus nauseosus **(Pall.) Britt.** (*Asteraceae*) (RABBITBRUSH).	Strongly scented, much-branched shrub, up to 2 m.	Introduced into India.	Recommended for cultivating on mined wastelands. Plant yields a rubber.
Chukrasia tabularis **A. Juss.** (incl var. *velutina* King) (*Meliaceae*) (CHITTAGONG WOOD; Beng–*Chikrassi;* Kan & Mar–*Dalmara;* Mal–*Malaveppu;* Tam–*Malaivembu;* Tel–*Chittagangukarra, errapogada;* Assam–*Boga-pogna;* TRADE–*Chickrassy*).	Tall, handsome, fast-growing tree, up to 48 m/up to 8.5 m. *Fl. & Fr.:* April–May; January–March.	In eastern and peninsular India, up to 1400 m; chiefly in western ghats; also in the Andamans. Found scattered in the moist, tropical hill-forest; prefers light, well-drained, porous soil. Coppices well. Through seed and stumps.	Suitable to grow on grassy blank, island-region and recommended for agro-forestry. Timber suitable for high-class furniture, house-building, paper-pulp, etc. Used as fuel (sapwood, 4817 kcl; heartwood, 5711 kcl/kg. Leaf used as fodder. Young leaf (22%) and bark (15%) yield tannins.
Citrullus colocynthis **(Linn.) Schrad.**	Prostrate or climbing,	Throughout India, up to 1500 m,	Suitable to grow in the arid, sandy

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syn. *Colocynthis vulgaris* Schrad. (1833) *(Cucurbitaceae)* (BITTER-APPLE, COLOCYNTH; Beng, Hindi & Mar–*Indrayan;* Guj–*Indrak;* Kan–*Pavamekkekaayi;* Mal & Tam–*Peykummutti;* Tel–*Eetiputcha, paparabudama*).	perennial herb.	especially in warmer parts. A trailer on sandy soils, black cotton-soil, and arid zones of Rajasthan and Gujarat. Very hardy and drought-resistant. Rapidly spreads; cultivated on riverbeds. Through seed.	regions for afforestation. Dried fruit-pulp yields colocynth drug. Fruit and root cooling, purgative; used in jaundice, urinary diseases and rheumatism. Fruit and seed eaten.
C. lanatus (Thunb.) Matsumara & Nakai syn. *Colocynthis vulgaris* Schrad. (1836); C.B. Clarke (Fl Br Ind) in part; *C. citrullus* (Linn.) Kuntze (WATERMELON; Beng, Guj, Hindi, Mar, Oriya & Urdu–*Karbuz;* Mal–*Tannima-than;* Tam–*Poiychavirai;* Tel–*Puchakaay;* Rajasthan–*Matira*).	Trailing or climbing, annual herb.	Cultivated on sandy soils throughout India; also found as an escape in waste places and agricultural fields; cultivated on sandy riverbeds. Fairly drought-resistant. Through seed.	Can be grown on slopy, gravelly soils to prevent run-off and highly acidic soils; also in hot and dry areas. Often grown on the sands of Rajasthan to stabilize sand-dunes. Fruit eaten fresh and in various preparations; a good source of sugar. Fruit-juice cooling and refreshing; possesses vitamin-C.
Cladium mariscus (Linn.) Pohl syn. *C. jamaicense* Crantz (*Cyperaceae*) (SAWGRASS OR STICKY GRASS).	Glabrous, stoloniferous perennial, up to 2.4 m.	Kashmir, at 1500–2400 m.	Can be grown in swamps or on shores of lakes. Stem excellent for thatching; sometimes used for making cheap paper. Seed contains protein (7.2%).
Cleome scaposa DC. syn. *C. gracilis* Edgew.; *C. papillosa* Steud. (*Cleomaceae*).	Erect, annual herb. *Fl.* & *Fr.:* August–December.	Rajasthan; arid regions. Through seed.	Grown to reclaim gravelly sites and eroded rocky surfaces.

C. vahliana Fresen. syn. *C. brachycarpa* Vahl ex DC. (Rajasthan–*Bagroomad*).	Erect, strongly scented, glandular herb, up to 15 cm.	Rajasthan and Jammu.	Can be grown to reclaim salty soils and eroded rocky surfaces. Herb used to treat skin-diseases.
Clerodendrum inerme Gaertn. syn. *C. coromandalanum* Spreng. (*Verbenaceae*) (Beng–*Banjai;* Hindi–*Sangkupi, vanjai* Kan–*Kundali;* Mal–*Cheruchinna, nirnochi;* Mar–*Vanajai;* Tam–*Pinarichanganguppi;* Tel–*Etipishinika*).	Erect, drooping or straggling, perennial undershrub or shrub, up to 3 m.	Throughout India, near the sea; cultivated as an ornament. Very hardy.	Recommended for estuarine areas; commonly cultivated as a hedge and to stabilize sand-dunes. Useful to grow in watersheds and seashores to check erosion. Leaf eaten with rice to increase appetite. Leaf-juice used as a febrifuge; substituted for quinine.
C. phlomidis Linn. f. syn. *C. phlomoidis* Linn. f. (Guj, Hindi & Mar–*Arni;* Kan–*Taggida;* Mal–*Thirutali;* Oriya–*Donkari;* Tam–*Takkari;* Tel–*Chiri, takkolamu*).	Large shrub or small tree, up to 10 m.	Throughout the drier parts of India from Punjab and West Bengal to South India. Found as a weed in cultivated fields; also found as an undergrowth of dry deciduous forests. Requires 200–250 mm rainfall. Through rootsucker.	Good soil-binder. Can also be grown on older alluvium. Leaf fed to cattle to treat diarrhoea, worms and swollen stomach. Flower also cooked with some curries.
Other *Clerodendrum* spp are also found on wastelands and have economic importance.			
Coix aquatica Roxb. (*Poaceae*).	Tall grass, up to 35 m.	Wild in low *jheels* of West Bengal as a floating weed.	Can be grown as a fodder in marshy wastelands.
C. gigantea Koenig ex Roxb. (WILD ADLAY; Beng–*Dangagurgur*).	Erect annual or perennial grass, up to 4 m.	Throughout marshy places of India. Hardy.	Suitable to grow in marshy places. Shelled grain suitable for poultry-feed. Fruit used for rosaries, ornamental trays, baskets and boxes.

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Species/Family/Names	Characters	Distribution/Propagation	Utilization
Colocasia esculenta (Linn.) Schott syn. *C. antiquorum* Schott (*Araceae*) (TARO, COCOYAM; Beng–*Kachu;* Guj–*Alvi;* Hindi, Mar & Punjab–*Arvi;* Kan–*Shamagadde;* Mal–*Shembu- kizhangu;* Oriya–*Saru;* Tam–*Seppan-kizhangu;* Tel–*Chaamadumpa, chaamagadda;* Assam–*Nagakachu;* Khasi–*Kashirew;* M P–*Bonga-bhaji;* Tripura–*Chhara*).	Perennial, tuberous herb, with very large, heart-shaped leaf.	Grows wild on the banks of streams, ponds and marshes and in moist and shady situations inside forests. Prefers warm, humid regions. Grows on all kinds of soils but thrives best in deep, well-drained, well-manured, friable loam. Cultivated as vegetable. Through sucker and daughter-corm.	Suitable for growing in waterlogged areas, bunds of paddy-fields, ponds and streams for reclamation. All parts edible. Starchy tuber used as potato and reported to be more nutritive than potato. Young leaf and stalk edible and can be cooked and eaten. Taro mucilage may be used for sizing impermeable paper.
Cordia dichotoma Forst.f. syn. *C. obliqua* Willd.; *C. myxa* Roxb., non Linn. (*Cordiaceae*) (SEBESTAN FRUITTREE; Beng-*Bahubara;* Guj–*Bargunda;* Hindi–*Chota-losora;* Kan–*Chikkachalle;* Mal–*Cheruviri;* Tam–*Naruvili;* Tel–*Chinnanakkeru;* Lepcha–*Nimat*).	Small tree, up to 15 m/up to 1.5 m, with a crooked trunk.	Widely distributed in India, especially warmer regions; cultivated for fruit. Tolerates moderate shade. Drought- and frost-hardy. Through seed and stem-cutting.	Suitable for saline and alkaline soil, brackish-water soils, gullies and ravines; also for semi-arid areas. Recommended for shelterbelts and for arid zones. Timber durable in water; used for well-curbs, boats, argicultural implements, furniture and veneers. Leaf used as cover for cheroot. Fruit sweet, edible; used as birdlime, astringent, demulcent; mucilage made into a glue.
C. gharaf Ehrenb. & Aschers. syn. *C. rothii* Roem. & Schult. (Guj & Hindi–*Gundi;* Kan–*Kirichalle;* Mar–	Small tree, up to 12 m. *Fl. & Fr.*:- March–April; May–June.	Rajasthan, Delhi, Uttar Pradesh, Gujarat and in peninsular India. Forms understorey of the dry,	Recommended for sand-dunes.Can be cultivated under xerophytic conditions. Timber used for

Gondani; Tam–*Naruvili;* Tel–*Chinnabotuku*).		deciduous, low forests and found associated with mixed xeromphic thorny forest in medium rainfall zone 250–350 mm.	agricultural implements. Yields fuel. Berry edible. Bark decoction used for gargle.
C. myxa Linn. (Hindi–*Lasora*).	Small or medium-sized tree.	Widely distributed in India, especially in warmer regions.	Recommended to cultivate for the afforestation of arid regions.
Coriaria nepalensis Wall. (*Coriaceae*) (MUSSORIE BERRY-TREE; Hindi–*Masuri;* Kashmir–*Balel*).	Deciduous shrub or small tree.	North-West Himalayas to Sikkim, up to 3300 m.	Suitable for growing on denuded hilltops. Wood used for boxes; also rich in tannins. Leaf contains tannins (20%); used as adulterant to senna. Fruit eaten, although insipid and reported to produce thirst and colic.
Corylus colurna Linn. (*Betulaceae*) (TURKISH HAZEL; Hindi–*Sharoli;* Kashmir–*Virin;* Kumaun–*Bhotia badam;* Punjab–*Thangi*).	Medium-sized, deciduous tree.	From Kashmir to Kumaun, at 1650–3000 m. Through transplanting seedlings.	Suitable for stabilization of soil; resistant to air-pollution;recommended for agro-forestry. Yields fodder for goats. Yields edible nuts.
Crataegus oxyacantha Linn. (*Rosaceae*) (ENGLISH HAWTHRON; H P–*Bansanji*).	Ornamental tree, up to 10 m.	North-West Himalayas, at 1800–2700 m.	Suitable for reclamation of cold deserts. Wood used for axehandles and walking-sticks. Fruit edible and made into preserves and sweetmeats; large source of vitamin-C. Liquid extract given as a cardiac tonic to reduce blood-pressure.

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Cressa cretica Linn. (*Convolvulaceae*) (Beng & Hindi–*Rudravanti;* Guj–*Una;* Mar–*Khardi;* Tel–*Uppusanaga*).	Small herb.	Throughtout India, grows in saline areas.	Recommended for saline flats and depressions and also in Rajasthan Desert on flat, exposed, piedmont plains.
Crotalaria burhia Buch.-Ham. ex Benth. (*Fabaceae*) (Guj–*Ghugharo;* Mar–*Ghagri;* Punjab–*Sissai*).	Erect, branched, slender shrub. *Fl. & Fr.:* September–December; February–May.	Arid, sandy parts of Punjab, Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh and Delhi, up to 1200 m; also found on older alluvium with hammocky and undulating. Rainfall 200–300 mm. Through seed.	Suitable for reclamation of sand-dunes, eroded rocky surfaces and piedmont plains. Good soil-binder. Used as fodder for camel. Fixes nitrogen. Leaf and branch used for cooling. Yields a fibre, similar to sunnhemp.
C. juncea Linn. (SANN- OR SUNNHEMP; Beng–*Shonpat;* Hindi–*Sannai;* Kan–*Sanabu;* Mal–*Wackoonar;* Tam–*Sannappu;* Tel–*Janumu*).	Erect, shrubby annual, up to 3 m.	Most commonly cultivated for fibre.	Recommended for social forestry. Also used as green manure. Fixes nitrogen. A good fodder (protein, 11.3%). Yields a major fibre. Seed may be useful for adhesives.
C. retusa Linn. (Beng–*Biljhunjhun;* Hindi–*Ghunghunian;* Mar–*Ghagri;* Tam–*Kilukilluppai;* Tel–*Pottigilligicha*).	Erect, robust undershrub, up to 6 m.	Common throughout India and also cultivated.	Recommended for estuaries. Fixes nitrogen. Yields a fibre.

Other *Crotalaria* spp can also be grown on saline and alkaline soils for reclamation, as green manure, covercrops and for fibre; also fix nitrogen.

Croton bonplandianum Baill. syn. *C. sparsiflorus* Morong. (*Euphorbiaceae*) (Tam–*Eliamanakku;* Tel–*Kukkamirapa;* Delhi & Bhopal–*Kalabhangra*).	Erect, much-branched, herb or undershrub.	Introduced into India from South America, naturalized and found as a weed throughout the year almost throughout India, chiefly in South India. Abundantly found along roadsides and railway-tracts, fallow-fields and also on other waste places.	Suitable for the reclamation of wastelands. Rich in potash and nitrogen; suitable for manuring. Seed also rich in potash and nitrogen; yields an oil; cake can be used as manure.
Crypsis schoenoides (Linn.) Lam. (*Poaceae*).	Annual, up to 30 cm, profusely branched at the base.	Punjab and Kashmir.	Recommended for fixation and reclamation of sand-dunes in areas of low rainfall.
Cryptomeria japonica (Linn. f.) D.Don (*Pinaceae*) (JAPANESE CEDAR).	Large, ornamental, evergreen tree, up to 24 m/ up to 2.1 m, with attractive foliage.	Introduced into India in Shimla, Darjiling, Assam and the Nilgiris. Prefers moist soils. Through seed and transplanting.	Very suitable for afforestation and to check landslides as it has resistance to uprooting. Timber useful for building, furniture, and for paper-pulp, etc. Timber and leaf (0.7%) yield an essential oil. Bark contains tannins (6%).
Dactylis glomerata Linn. (*Poaceae*) (COCKSFOOT GRASS, ORCHARD-GRASS).	Tufted perennial, up to 90 cm.	From Kashmir to Kumaun, Meghalaya, at 2100–3000 m, and on the Nilgiris; grows on almost all kinds of soils. Well-adapted for growing under shade. Through division.	Suitable for stabilization of sand and checking soil-erosion as it has a deep rootsystem and withstands heavy grazing; grows on smelter waste. A potential source of fodder (protein, 1.9–4.1%) in temperate regions; used both for hay and pasture.
Dactyloctenium aegyptium Beauv. syn. *Eleusine aegyptiaca* Desf. (*Poaceae*)	Very variable annual, up to 1 m. *Fl. & Fr.:*	Throughout the plains of India, up to 1500 m. Found on poor, dry	Can be grown on deep sandy soils and saline flats. Useful fodder

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Species/Family/Names	Characters	Distribution/Propagation	Utilization
(Hindi–*Makra;* Oriya–*Kakuriya;* Bombay–*Manchi;* M P & Punjab–*Madhana*).	September–January.	soils, older alluvium with flat topography, saline flats and depressions in Rajasthan Desert. Also found on deep sandy soils, and cultivated fields and roadsides, rooting and branching proliferously at nodes.	(crude protein, 7.25%) for horses. Grain eaten in times of scarcity.
D. australe Steud.	Stoloniferous, perennial grass.	Native to South Africa, introduced into India for lawn. Can withstand some shade.	An excellent sand-binder and forms a good sward.
D. scindicum Boiss. syn. *Eleusine scindica* Duthie; *E. aristata* Ehrenb. ex Boiss. (Punjab–*Bhobra;* Rajasthan–*Tantia*).	Slender, perennial. *Fl.* & *Fr.:* September–January.	Sandy tracts of North India. Found on mineral soils also. Rainfall 150–300 mm.	Suitable for the reclamation of eroded rocky surfaces and piedmont plains. A good fodder.
Delonix elata Gamble syn. *Poinciana elata* Linn. (*Caesalpiniaceae*) (WHITE GOLDMOHUR; Kan–*Kempukenjiga;* Mar–*Sankasura;* Tam–*Vadanarayana;* Tel–*Sankesula, vatanarayana*).	Fairly fast-growing, erect tree, up to 6–10 m. *Fl.* & *Fr.:* Hot season.	Wild in Gujarat and South India, cultivated everywhere. Through seed and cutting.	Planted to protect the river- and channel-banks; and for live-fences; recommended for agroforestry, Twigs and leaves used as manure. Timber used for cabinet-work, combs, matches. Leaf used in rheumatism and flatulence.
D. regia Rafin. syn. *Poinciana regia* Bojer ex Hook. (FLAMEBOYANT	Fast-growing, medium-sized, ornamental tree. *Fl.*	Cultivated all over warmer and damper parts of India. Through seed	Commonly planted in avenues and gardens on all soils; recommended

FLAMETREE, GULMOHUR; Tam–*Mayarum;* Tel–*Seemasankesula*).	*& Fr.:* Hot season.	and cutting.	for agro- and social forestry. Seed yields a gum which may be used in foods and textile.
Dendrocalamus hamiltonii Nees & Arn. (*Poaceae*) (Beng–*Pecha;* Hindi–*Kaghsibans;* Assam–*Kokua;* Lepcha–*Pao*).	Tall, erect, large, bamboo, often sending out culms at an angle or curved downwards, up to 25 m/ up to 1.0 m.	Sub-Himalayan region from Punjab to Assam and Meghalaya, up to 1200 m. Cultivated up to 2000 m in adjacent valleys of Dehra Dun.	Grown as windbreaks and to protect tea-plantations. Bamboo is used for a variety of purposes, and for paper; suitable for water-conduits. Young shoot used as vegetable.
D. longispathus Kurz (Beng–*Khang;* TRADE–*Orah*).	Large, caespitose, handsome, tufted bamboo, up to 20 m/62 cm.	Some parts of lower West Bengal and Assam, usually along streams, up to 1600 m.	Can be grown on poor and skeletal, stony soils and in ravines with medium rainfall. Useful for kraft-paper.
D. strictus Nees (MALE BAMBOO, SOLID BAMBOO; Beng–*Karail;* Guj–*Nakorvans;* Hindi–*Banskaban;* Kan–*Kiribidiru;* Mal & Tam–*Kalmungil;* Mar–*Bhariyel;* Oriya–*Saliabanso;* Sans–*Vansha;* Tel–*Saadharanapuveduru*).	Deciduous, densely tufted bamboo, up to 20 m. *Fl. & Fr.:* November–February; April–June.	Throughout India, up to 1500 m; commonly found in deciduous forests and in dry or moderately dry regions. Thrives on any soil, provided not waterlogged and well-drained; prefers light, porous gravelly and sandy loam. Withstands drought and frost. Through seed, division of offset, stem- or rhizome-cutting and layer.	Can be grown on all well-drained soils, including alluvial plains, gullies and ravines, hillslopes and semi-arid areas for afforestation, soil-conservation and reclamation. Recommended for social forestry and windbreak. Culm used for construction, wickerwork, etc. Important source of paper-pulp. Leaf lopped for fodder. Tender shoots made into curries and pickles.
Deschampsia caespitosa Beauv. (*Poaceae*) (TUFTED-HAIR GRASS).	Densely tufted, ornamental perennial, up to 90 cm.	From Kashmir to Bhutan, at 3000–4950 m.	Early colonizer on mined areas; hence recommended for recla-

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
			mation. Yields a coarse fodder before bloom (crude protein, 8.54%). Used for doormats.
D. flexuosa (Linn.) Trin.	–	Introduced into India.	Early colonizer on acidic soils.
Desmodium diffusum DC. (*Fabaceae*) (Bombay–*Patada; Shevra, chikta*).	Herb, up to 60 cm.	Throughout the greater part of India; plains of West Bengal, Bihar, Orissa, Madhya Pradesh, Maharashtra, Karnataka and Andhra Pradesh.	Cultivation on typical black cotton-soil brings about greater improvement in soil-structure and nitrogen; useful as green manure and as forage.
D. heterocarpum (Linn.) DC. syn. *D. polycarpum* DC. (Oriya–*Krishnupani;* Tel–*Chepputatta;* Santal–*Baephol*).	Erect or sub-erect under-shrub, up to 3.0 m.	Throughout India, up to 2000 m.	Suitable for planting on terraces and slopes for preventing erosion. Useful as green manure and cover-crop in coconut plantations. Fixes nitrogen.
D. tortuosum DC. (BEGGERWEED).	Erect annual, up to 2.4 m.	Introduced from Central America into India for forage.	Very useful to grow on light, sandy soils to keep such soils suitable for cultivation; good cover-crop. Fixes nitrogen. Better than alfalfa as forage (dig. protein, 3.2%) for poultry and can be converted into hay (dig. protein, 11.1%).
D. triflorum DC. (Beng & Hindi–*Kudaliya;* Mar–*Janglimethi;* Tam–	Small, perennial, spreading herb.	Common throughout India, up to 2800 m. Through dense mat of	Particularly suitable for dry,rocky soils and also for saline and

Sirupulladi; Tel–*Muntamandu*).		roots it spreads.	alkaline soils; effective in preventing soil-erosion. Forms lawn. Fixes nitrogen. May be grown as cover-plant. Yields good fodder.
Digera muricata (Linn.) Mart. syn. *D. arvensis* Forsk. (*Amaranthaceae*) (Beng–*Gungatiya;* Hindi–*Latmhuria;* Mar–*Gitana;* Tam–*Thoyyakeerai;* Tel–*Chenchali-koora;* Punjab–*Tartara*).	Annual or perennial herb, up to 60 cm.	Throughout the plains of India. Found as a common weed in cultivated fields, pastures and wastelands; found on rocks, lower and upper piedmont plains in Rajasthan. Through seed.	Suitable for growing on rocks and deep sandy soils, and other waste places. Relished by cattle. Leaf and tender shoot eaten as potherb. Flower and seed are used for urinary discharges.
Digitaria ciliaris (Retz.) Koeler syn. *Panicum ciliare* Retz.; *Paspalum sanguinale* Lam. var. *ciliare* Hook. f.; *Digitaria adscendens* (H. B. & K.) Henr.; *D. marginata* Linn. (incl. var. *fimbriata* Stapf) (*Poaceae*) (CRABGRASS; FINGER-GRASS; Hindi–*Takri;* Kan *Hennu-akkibuhullu;* Tam–*Arisipillu;* Bombay–*Shikool, chansarieu*).	Prostrate or decumbent, perennial, up to 1 m. *Fl. & Fr.:* August–October.	Widely distributed in India, both in plains and on hills. Found as a weed in lawns, etc.	Suitable for semi-arid and arid regions and for sandy areas, hilly tracts and swampy places. Used as fodder.
D. longiflora (Retz.) Pers. syn. *Paspalum longiflorum* Retz. (Hindi–*Kanakajariya;* Kan–*Taparihullu;* Tel–*Paakudugaddi*).	Creeping annual or sometimes short-lived perennial.	Punjab.	Rapidly occupies open, sunny places. Grown for lawns. All grazing animals relish it.
D. pentzii Stent (WOOLLY FINGER-GRASS).	Perennial grass.	Native to South Africa, introduced into India. Through root.	Easily covers the ground with its stolons, conserve soil-moisture and suppresses weeds; very resistant to heavy grazing and possesses exceptional powers of recuperation. Excellent for hay.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Dinebra retroflexa Panz. syn. *D. arabica* Jacq.; *Cynosurus retroflexus* Vahl (*Poaceea*) (Kan–*Naribaladagan-duhullu;* Tel–*Udatatookagaddi;* Bombay–*Kali kauli*).	Low, erect, tufted annual, up to 90 cm. *Fl. & Fr.:* October.	Common weed in cultivated fields in Madhya Pradesh, western India and Tamil Nadu. Grows in dry fields after harvest. Prefers alkali earth metals and black soil.	Suitable for the reclamation of alkaline and black heavy soils. An excellent fodder (protein, 1.01–1.56%) for cattle.
Diospyros melanoxylon Roxb. syn. *D. tupru* Buch-Ham. * *D. tomentosa* Roxb. (*Ebenaceae*) (COROMANDAL EBONY-PERSIMMON; Beng–*Kend;* Guj–*Tamrug;* Hindi & Mar–*Tendu;* Kan–*Abanasi; tumari;* Mal–*Kari;* Oriya–*Kendu;* Tam-*Karai ,tumbi;* Tel–*Tumki, mancitumki nallatumki;* TRADE–*Ebony*).	Tree, up to 24 m. *Fl. & Fr.:* January–August.	In sub-Himalayan tract from Punjab to Nepal; Rajasthan, Madhya Pradesh, Maharashtra, Bihar and Orissa and peninsular India; commonly found in dry mixed and deciduous forest. Rainfall required 50–150 cm. Resistant to drought and frost. Coppices and pollards well. Through seed and rootsucker.	Important for afforestation on black soils and also appears on poor soils; recommended for social forestry. Yields fuel. Leaf highly esteemed for wrapping bidis. Fruit edible. Various parts of plant rich in tannins (15–23%).
Dipterygium glaucum Decne (*Brassicaceae*).	Rigid shrub.	Arid zones of Rajasthan and Punjab.	Useful for the reclamation of sand-dunes of Rajasthan.
Donax arundinastrum Lour. syn *Phryninum dichotomum* Roxb.; *Clinogyne dichotoma* Salisb. (*Marantaceae*) (Beng–*Sitalpati;* Assam & Tripura–*Murta*).	Shrub, up to 4 m, with an erect, glossy-green stem.	Assam, West Bengal and Coromandel coast; cultivated in West Bengal. Through rootstock or rootcutting.	Suitable to grow on water-logged areas. Rhizome yields a commercial starch. Split-stem used for mats. Pith useful for paper.
Drymaria cordata Willd. (*Caryophyllaceae*).	Sub-erect herb.	Tropical and sub-tropical India, up to 2100 m in Sikkim Himalayas.	Suitable for ground-cover to prevent soil-erosion, particularly

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* Considered separate by some authors.

			on steep slopes. Useful for fodder. Juice laxative and anti-febrile.
Dyerophytum indicum (Gibs. ex Wight) Kuntze syn. *Vogelia indica* Gibs. ex Wight (*Plumbaginaceae*).	Perennial shrub. *Fl. & Fr.:* September–February.	Western India on dry, rocky hill-slopes, as undergrowth of dry, deciduous, low forests.	Suitable for afforestation of dry, rocky slopes.
Elaeagnus angustifolia Linn. syn. *E. hortensis* Bieb. (*Elaeagnaceae*) (OLEASTER).	Fast-growing, deciduous shrub or small tree, up to 9 m/ up to 1.8 m.	Western Himalayas, at 1600–3300 m. Thrives under a wide range of soil and moisture conditions. Drought-resistant and salt-tolerant. Through seed, cutting and layer.	Good for reclamation of spoil-mounds and sandy calcareous soils; industrial wastelands and manganese spoils can also be improved. Fixes nitrogen. Yields fuel. Used as fodder for sheep and goat. Fruit favoured food of birds and mammals.
E. umbellata Thumb. (Punjab–*Bammerwa, kenkoli*).	Much-branched, often spiny, deciduous shrub, 4 m or more.	Temperate Himalayas, from Kashmir to Nepal,at 3000 m,and in Manipur.	Recommended for reclamation of highly acidic spoils and for control of erosion. Fixes nitrogen. Wood used as fuel. Flower cardiac, astringent. Fruit edible; pickled or eaten in curries.
Eleusine indica (Linn.) Gaertn. (*Poaceae*) (CROWFOOT GRASS; CRABGRASS; Hindi–*Mandla;* Oriya–*Nandia;* Tam & Tel–*Tipparaagi;* Bombay–*Maharnachni*).	Tufted annual.	Wet plains and low hills, up to 1950 m, found in pastures and roadsides.	Rapidly grows; a useful soil-binder. Very nutritious grass; can be converted into hay.
Ephedra foliata Boiss. & Kotschy ex Boiss. (*Ephedraceae*) (Rajasthan–*Andho khimp*).	Tall, climbing shrub.	Punjab and arid zones of Rajasthan. Found on old alluvial, sandy, gravel or even on rocks.	Suitable for cultivation on denuded rocky places. Fruit eaten.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
E. gerardiana Wall. syn. *E. vulgaris* Hook. f. (Fl Br Ind), non A. Rich (H P–*Asmania;* Ladakh–*Teapat;* Bashahr–*Rachi*).	Small shrub, not more than a few centimeters.	Drier regions of temperate and alpine Himalayas, from Kashmir to Sikkim, at 2500–5500 m in places like Pangi, Shimla, Lahul and Spiti, Kunawar, Kashmir and Ladakh. Rainfall below 50 cm. Drought-resistant. Through seed, layer, division of rootstock.	Satisfactorily grows even in extreme xerophytic conditions. Rhizome large, used as fuel in Tibet.
Ephedra spp yield ephedrine. Fruit sweet, edible.			
Eragrostiella bifaria (Wight ex Steud.) Bor syn. *Eragrostis bifaria* Wight ex Steud. (*Poaceae*) (Kan–*Kodaimarahullu;* Tam–*Oothupul;* Tel–*Gubbikal-* or *nootigaddi;* Bombay–*Chiraka*).	Densely tufted, erect perennial, up to 90 cm.	Maharashtra, Gujarat, Rajasthan, up to 1500 m.	Suitable for reclamation of sandy and rocky areas. Readily grazed by cattle. Root used for flavouring cheroots.
Eragrostis ciliaris (Linn.) R. Br. (*Poaceae*) (Rajasthan–*Underpuncho*).	Annual grass, up to 100 cm.	Arid regions of Rajasthan.	Suitable for growing in sandy habitats, waste and neglected places. Grazed by cattle.
E. curvula (Steud.) Nees (WEEPING LOVEGRASS).	–	Introduced from South Africa into India for conservation.	Suitable for saline and alkaline soils; tolerates arid conditions in coal-spoils. Gives a rapid cover in dry regions with low fertility.
E. gangetica Steud. (Bombay–*Todha;* U P–*Jenkna*).	Perennial grass.	Throughout India.	Suitable for growing in low-lying swampy grounds. Eaten by cattle either green or as hay. Also used for brooms.

E. nigra Nees ex Steud.	Annual grass.	Widespread in India.	Very common on hills and other waste places.
E. pilosa Beauv. (Kan–*Kaadusannasamaihullu;* Tam–*Kuthiravalpul;* Bombay–*Burwai;* Punjab–*Nikasanwak;* U P–*Phularwa*).	Tufted, erect annual, up to 90 cm.	Throughout India.	Suitable for wet and marshy soils. Considered to be a good fodder.
E. plumosa Link. syn. *E. tenella* Beauv. ex. Roem. & Schult. var. *plumosa* Stapf (Hindi–*Jhusa;* Kan–*Sannapuralaihullu;* Tam–*Poopul;* Tel–*Chinnagarikigaddi;* Punjab–*Budhan*).	Slender, tufted annual, 40 cm or more.	Throughout India, up to 1200 m; subgregarious and in sandy and *usar* soils.	Suitable for growing in sandy and *usar* soils. Given as green fodder (crude protein, 9.91%) or hay. Grain nutritious.
E. superba Peyr	Caespitose perennial, up to 1.2 m.	Native to tropical Africa,introduced into India.	Grows on sandy places in its native home and therefore can be cultivated for reclamation of such areas.Moderately good for pasture and hay-making.
E. tenelle Beauv. ex Roem. & Schult. (Tel–*Pothikagaddi;* Bombay–*Dhane, bharbhusi*).	Small, elegant slender, loosely tufted annual, up to 75 cm.	Throughout the plains; common on cultivated ground, waste places and well-grazed grasslands. Also found on damp sands of streams.	Can be grown on waste and moist places. Grass eaten by cattle both green or as hay.
E tremula Hochst. ex Steud. syn. *E. rachitricha* Hochst. ex Miq. (Bombay–*Chirka;* Punjab–*Laki;* Rajasthan–*Chuvalio*).	Sub-gregarious, tufted annual, up to 75 cm.	Almost throughout India. Grows on light sandy soils, especially on poorly cultivated ground.	Suitable for growing in arid and deep sandy soils. Good fodder (protein, 3.08%). Grain eaten.
E. trichoides (Nutt.) Wood	–	Introduced into India.	Suitable for barren, sandy land.

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Species/Family/Names	Characters	Distribution/Propagation	Utilization
E. viscosa (Retz.) Trin. syn. *E. tenella* Beauv. ex Roem. & Schult. var. *viscosa* Stapf	Tufted, annual grass.	From Gangetic plains to South. Grows on sandy soil in damp places.	Suitable for damp places. Eaten by cattle.
Eremopogon foveolatus Stapf syn. *Andropogon fovelolatus* Delile (*Poaceae*) (Bombay–*Ghandel boari;* Tel–*Nanaballugaddi*).	Densely tufted, sporadic grass, up to 60 cm.	Found in dry situations, almost throughout India. Grows on all kinds of soils, including laterite but prefers calcareous soils.	Can be grown in arid, deep, sandy soils and rangelands. Good desert-fodder (protein, 2.27%), especially for camels.
Erythrina corallodendrum Linn. (*Fabaceae*). (RED BEANTREE).	Small tree.	Native to the West Indies, introduced into Indian gardens.	Stabilizes zircon and rutile minesites on beach-sands. Fixes nitrogen.
E. indica Lam. syn. *E. variegata* Linn. var. *orientalis* (Linn.) Merrill (INDIAN CORAL-TREE; Beng–*Palita mandar;* Guj–*Bangaro;* Hindi–*Dadap;* Kan–*Harivana;* Mal & Tam–*Kalyanamurukku;* Mar–*Mandar;* Sans–*Mandara;* Tel–*Baadita, moduga*).	Medium-sized, quick-growing tree, up to 18 m. *Fl. & Fr.*: February–May; May–July.	Throughout India; also in the Andaman and Nicobar Islands; often cultivated for ornament. Found wild in deciduous forests and on seacoast. Through seed and stem-cutting.	Planted for shelter-belts, hedges, shade and supports. Suitable for grassy blanks. Fixes nitrogen. Recommended for agro- and social forestry. Grown for support to betel- and pepper-vines, grape, jasmine, etc. Timber used for rafts, floats, etc. Tender leaf (protein, 16.73%) given as fodder, and also eaten. Bark yields a fibre. Boiled and roasted seed eaten.
Other *Erythrina* spp also are grown as hedges.			
Fagonia cretica Linn. syn. *F. arabica*	Small spiny, undershrub.	Punjab, Uttar Pradesh, Rajasthan	Very common in arid regions.

Linn.; *F. bruguieri* DC. (*Zygophyllaceae*) (Guj & Mar–*Dhamasa;* Hindi–*Ustar-khar;* Tel–*Chittigara;* Punjab–*Dama;* Rajasthan–*Damasha*).	*Fl. & Fr.:* October–February.	and Deccan. Grows on gravelly soil.	Tolerates lime and gypsum and suitable for growing in such places. Twig used as tooth-brushes.
Fagopyrum esculentum Moench (*Polygonaceae*) (COMMON BUCKWHEAT;Hindi–*Kotu;* Assam–*Doron;* Darjiling–*Tifaphapur;* Punjab–*Daran*).	Quick-growing, annual herb, up to 1.5 m. *Fl. & Fr.:* April–August; July–October.	Cultivated at the higher altitudes of Himalayas from Kashmir to Sikkim, Meghalaya and Manipur and on the Nilgiris. Grows in moist, cool climate and on well-drained sandy soil. Through seed.	Acts as a soil-binder preventing erosion during heavy rainfall. Excellent crop for soil-improvement, particularly for lands newly opened or poor soils which do not support any other cereal crop; forms an excellent cover. Produces large quantity of green matter, which can be used as green manure. Hulls can be used as fuel, bedding for farm animals and packing. Grain given as feed; also used for bread, pancakes and porridge.
Farsetia jacquemontii Hook. f. & Thoms. (*Brassicaceae*) (Punjab–*Faridbuti*).	Much-branched, hairy shrub.	In Rajasthan, found on burried piedmont plains, with a rainfall of 200–250 mm.	Suitable for reclamation of sand-tract. Forage-plant of the dunes. Used in rheumatism. Tender twigs made into a chutney; also eaten raw as tonic.
Festuca olgae (Regel) Krivot (*Poaceae*).	Erect or ascending, densely tufted, dioecious perennial, without rhizome, up to 85 cm. *Fl. & Fr.:* July–August.	Western Himalayas; grows on rocky, dry slopes or on the ledges of cliffs, sometimes found on steep, dry slopes.	Useful colonizer of rocky, dry slopes and a soil-binder.

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Species/Family/Names	Characters	Distribution/Propagation	Utilization
F. ovina Linn. [incl. ssp *coelestis* St Yves & ssp *polycolea* (Stapf) St Yves] (SHEEP'S FESCUE).	Densely clustered perennial, up to 40 cm.	Found in North India, particularly on the mountains.	Recommended for metalliferous soils.
F. rubra Linn. (incl. vars) (RED FESCUE).	Loosely or densely clustered, ascending or stoloniferous grass, up to 90 cm.	Widely distributed and found in mixtures for pastures and lawns, at 1500–4500 m.	Recommended for calcareous metalliferous soils and for sand-stilling; tolerates low fertility and provides rapid cover.
Ficus beng(h)alensis Linn. (*Moraceae*) (THE BANYAN TREE; Beng–*Bar;* Guj–*Vad;* Hindi–*Bargad;* Kan–*Ala;* Mal–*Ala, vatam;* Mar–*Vada;* Sans–*Bahupada;* Tam–*Al;* Tel–*Peddamarri*).	Very large, fast-growing, evergreen tree, up to 30 m, with spreading branches, and many aerial roots.	Throughout the forest-tracts of India. Also grown in gardens and roadsides for shade. Hardy, drought-resistant and withstands mild frost. Through seed, transplanting and stem-cutting.	Can be used to control stream-banks, deep sandy loams. Timber used for well-curbs, furniture, etc.; suitable for paper-pulp. Leaf (crude protein, 9.63%) lopped for fodder. Ripe (protein, 8.1%) fruit eaten.
F. glomerata Roxb. syn. *F. racemosa* Linn. (Beng–*Dumur;* Guj–*Umar;* Hindi–*Gular;* Kan, Mal & Tam–*Athi;* Mar–*Umbar;* Oriya–*Dimra;* Tel–*Atti, medichettu*).	Moderate-sized to large, spreading tree. *Fr.*: March–July.	Found throughout the greater part of India in moist localities. Grows on a variety of soils. Drought- and frost-resistant. Coppices well. Through seedling and branch-cutting.	Can be grown on a variety of soils, such as coarse soils along the ravines, rocky hill-slopes, stream-banks and grassy blanks; recommended for social forestry. Timber used for well-curbs and construction; suitable for matchboxes. Leaf (crude protein 12.36%) used as fodder for cattle and elephants. Fully ripe fruit (protein, 7.4%) and its flour may be eaten along with milk and sugar. Powder a valuable breakfast food. Latex used for *groundsheets and waterproof-bonded paper.*

F. semicordata Buch.- Ham. ex J.E.Sm. syn. *F. cunia* Buch.-Ham. (Beng–*Dumbur;* Hindi–*Jahrphali;* Kan–*Gargasa;* Mal-*Perina;* Mar–*Porodumer;* Tam–*Targadi;* Tel–*Bommamarri*).	Moderate-sized tree. Fruits borne underground on runners; ripen from March and continue all through the year.	From Jammu & Kashmir to Bhutan, Assam, West Bengal, and Orissa, up to 1300 m. Common on the banks of streams and ravines.	Can be grown to control stream-banks and ravines. Leaf valued as fodder. Bark yields strong fibre. Fruit (protein, 8.7%) eaten.
F. religiosa Linn. (THE PEEPAL-TREE; Beng & Sans–*Ashthwa;* Guj–*Pipro;* Hindi–*Pipal;* Kan–*Arali, ashwatha;* Mal–*Arachw;* Mar–*Pimpala;* Tam–*Arasu;* Tel–*Ashvathamu, raavichettu, bodhi*).	Large, deciduous tree, epiphytic when young.	Found wild or cultivated nearly throughout India. Planted in avenues and on roadside. Grows on alluvial soils, shallow soils and in rocky crevices.	Can be used for the control of streambanks; recommended for agro-forestry. Timber used for packing-cases, wheels, spoons, etc.; suitable for matchboxes. Twig lopped for fodder (crude protein, 13.99%). Tender leafbud and fruit eaten. Bark yields tannins (4%).
Flacourtia indica (Burm. f.) Merrill syn. *F. sepiaria* Roxb.; *F. latifolia* Cooke (*Flacourtiaceae*) (Guj–*Lodri;* Hindi–*Kondari;* Kan–*Miride;* Mal–*Kurumuli;* Mar–*Atran;* Oriya–*Sanubainchi;* Tel–*Kaanaregu*).	Small, rigid shrub or tree, with long, sharp spines. *Fl. & Fr.:* January–April.	Throughout the greater part of India, found on hill-slopes; forms understorey of dry, deciduous, low forests. Through seed.	Recommended for afforestation of ravines and mineral soil. Grown as a hedge. Timber used for ploughs, rough beams, posts, and charcoal. Leaf given as fodder.
Furcraea foetida (Linn.) Haw. syn. *F. gigantea* Vent. (*Amaryllidaceae*) (MAURITIUS HEMP).	Large shrub, with 20–40 fleshy leaves, sharply ascending from a short trunk. Seeds once in its lifetime.	Introduced and cultivated in gardens in Karnataka, Tamil Nadu, Maharashtra, West Bengal and Assam. Thrives on all types of soils and favours growth where temperature is uniformly high and water is abundant. Through bulbils.	*Furcraea* spp grow on rough, dry soils and can be planted along railway-embankments, roadsides, etc.; also suitable for hedges, fences and as windbreaks for checking soil-erosion. Leaf of *F. foetida* yields a commercial fibre (MAURITIUS HEMP), suitable for cordage, shoe-

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
			soles, mats, etc. Potash and wood-alcohol may be obtained after extacting fibre. Other species also may yield fibre.
Other species grown are: *F. bedinghausii* Koch, *F. hexapetala* Urb. syn. *F.cubensis* Vent., *F. longaeva* Karw. & Zucc. and *F. selloa* Koch var. *marginata* Trel. syn. *F. lindenii* Jacobi.			
Gardenia turgida Roxb. (*Rubiaceae*) (Hindi–*Thanella;* Kan–*Bengeri;* Mal–*Malankara, kharkar;* Mar–*Pendra;* Oriya–*Bomonia;* Tam–*Malangarai;* Tel–*Yerra-bikki, tellakokkita;* M P–*Karhar;* Rajasthan–*Karumba*).	Small deciduous, spiny tree.	Throughout the greater part of India in dry, open deciduous forests, up to 1200 m in the outer Himalayas. Drought- and frost-resistant.	Useful for reclaiming dry, stony soils, rocky hill-ridge, laterite *kankar* and stiff clayey situations and for afforestation. Timber used for walking-sticks, musical instruments, etc. Good firewood. Substitute for boxwood. Tree yields gum.
Garuga pinnata Roxb.(*Burseraceae*) (Beng–*Jum;* Guj–*Khusimb;* Hindi–*Kharpat;* Kan–*Halabalagi;* Mal–*Kosramba;* Mar–*Kakad;* Oriya–*Mohi;* Tam–*Karrevembau;* Tel–*Garuga;* Assam–*Thotmola;* Bihar–*Kandwer;* Khasi–*Diengkhiang*).	Medium-sized, deciduous tree, up to 15 m / up to 1.8 m, covered with galls.	Almost throughout India; occasionally cultivated. Widely distributed in dry and moist deciduous forests; prevalent on cool aspects and in ravines. Strong light-demander. Coppices well. Produces rootsuckers. Fire-resistant; possesses good power of recovery. Through seed, transplanting and cutting.	Since resistant to fire and easy to propagate, tree is valuable for afforestation. Also recommended for agro-forestry. Heartwood suitable for furniture, planking, boxes, cabinet-work, plywood, match-splints, pulp, etc. Used as firewood; yields a good-quality charcoal. Leaf valued for fodder. Bark and leafgall are used for tanning. Fruit eaten raw, pickled or cooked.

Glaux maritima Linn. (*Primulaceae*) (SEA-MILKWORT).	Herbaceous halophyte, with fleshy leaves.	Introduced into India.	Suitable for cultivation on saline soils. Young shoots used in salads.
Gliricidia sepium (Jacq.) Kunth ex Walp. syn. *G. maculata* Steud. (*Fabaceae*) (MOTHER-OF-COCOA, MEXICAN LILAC).	Fast-growing, small or medium-sized, ornamental tree, up to 10 m.	Introduced from tropical America, cultivated in peninsular India, up to 900 m. Does well in moist or dry soil, even with heavy concentrations of limestone. Drought-tolerant, and shade-bearing. Through seed and large cutting.	Suitable as terrace-stabilizer and for reclaiming black soils, gullies and ravines; efficiently fixes nitrogen and enriches poor soil; used as green manure, live-fences and for shade; leaf a good mulch and preserves groundwater; recommended for social forestry. Timber used for posts, fences, stakes and railway-cross-ties and firewood. Leaf (protein, 5.1%) used as fodder. Flower a good source of honey.
Grewia elastica Royle syn. *G. vestita* Wall. ex Mast.; *G. asiatica* Linn. var. *vestita* Mast. (*Tiliaceae*) (Beng–*Dhamni;* Hindi & Punjab–*Dhaman;* Oriya–*Mirgichara;* Assam–*Manbijal*).	Deciduous tree, up to 18 m/up to 1.5 m.	Sub-Himalayan tracts, up to 1200 m, Central India, western ghats and Kerala. Drought- and frost-resistant. Freely coppices and rapidly develops.	Recommended for agro-forestry. Timber used for shafts, poles, etc. Yields good fuel (4920 kcal/kg). Leaf lopped for fodder. Bark yields a fibre.
* *G. subinequalis* DC. syn. *G. asiatica* Mast. (Fl Br Ind) in part, non Linn.; *G. hainesiana* Hole (Beng, Guj, Hindi, Mar & Punjab–*Phalsa;* Kan–*Bhuttiyudippe;* Oriya–*Pharasakoli;* Tam–*Palisa;* Tel–*Nallajana*).	Fast-growing small tree or straggling shrub.	Found in greater part of India.	Can be grown on a wide range of soils. Recommended for agroforestry. Root-bark yields a fibre. Fruit eaten as dessert.

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* Some consider the cultivated *Phalsa* to be *G. asiatica* Linn.;and *G. hainesiana* Hole a separate species.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
G. tenax (Forsk.) Aschers. & Schwf. syn. *G. populifolia* Vahl (Guj–*Gangeti;* Tam–*Achchu;* Tel–*Gundukadira;* Punjab–*Gangukanger;* Rajasthan–*Gangerun*).	Much-branched shrub or small tree, up to 2 m.	Arid areas of Punjab, Rajasthan, Central India and the Deccan. Found in dry, deciduous, low forests and in mixed xeromphic thorny forests of low-rainfall zone.	Useful for reclaiming pale-brown to light-brown gravelly, non-calcareous, somewhat compact loamy-sand soils, rock-fragments and cobbles coated with lime below. Produces considerable biomass. Timber used for walking-sticks; suitable for pencils. Leaf lopped for fodder for camels and goats. Fruit edible.
Hackelochloa granularis (Linn.) Kuntze syn. *Manisuris granularis* Linn. f. (*Poaceae*) (Guj–*Kasiunghas;* Hindi–*Trinpali;* Kan–*Kaddusannaharkahullu;* Tel–*Gurusingugaddi, kurujedanagaddi*).	Annual grass, up to 1m. *Fl. & Fr.:* August–November.	Warmer parts of India, in open grasslands and cultivated fields; thrives well on dry and wet soils.	Recommended for arid, sand-stone, rocky, semi-rocky and gravelly soils. Moderately good fodder (protein, 6.35%); suitable for hay.
Halopyrum mucronatum Stapf (*Poaceae*).	Erect grass, with thick roots and woolly root-hairs, grows in huge tufts.	Found on the coast from Gujarat to Tamil Nadu.	Recommended for the reclamation of coastal saline soils; excellent sand-binder and grows well on the sand-dunes at the limit of high tide and acts as a buffer between the sea and dunes. Valuable fodder.
Haloxylon recurvum Bunge ex Boiss. (*Chenopodiaceae*) (Rajasthan–*Khar*).	Tall, perennial bush or undershrub. *Fl. & Fr.:* October–November.	Punjab plains southwards to peninsular India.	Halophyte; grows in moist places. Used as fodder for camels. Source of crude sodium carbonate,

			used for making soap and glass. Ash used for washing clothes and also given for internal ulcers.
H. multiflorum Bunge (Rajasthan–*Lona*).	Low, erect, almost leafless shrub.	Punjab and Rajasthan on salty land, with rainfall up to 200 mm.	Good soil-binder. Useful for salty areas.
H. salicornicum Bunge	–do–	–do–	Good soil-binder. Suitable for arid areas, saline flats and depressions.
Hardwickia binata **Roxb.** (*Caesalpiniaceae*) (Hindi, Mar & Sans–*Anjan;* Kan–*Kamra;* Tam–*Acha;* Tel–*Yepi;* Bombay–*Parsid;* Gond–*Chhota-dundhera;* TRADE–*Anjan*).	Deciduous tree, up to 30 m/up to 4.5 m.	Dry, savannah forests of the Deccan peninsula, Central India and parts of Bihar, U P and Delhi; also cultivated. Drought- and frost-resistant. Coppicing not proper, but pollards well. Produces suckers. Through seed, transplanting and root-sucker.	Suitable for dry climate and dry, shallow soil and rocky ground, porous sandy loams; planted for windbreaks and shelter-belts; recommended for social forestry. Timber used for naves of cart-wheels, oilmills, ploughs, etc. Yields a moderately good fuel. Leaf used for fodder (protein, 10.79%) and manure. Bark yields a fibre, used for ropes.
Heritiera littoralis **Dryand.** (*Sterculiaceae*) (LOOKING-GLASS TREE; Kan–*Chandmara;* Mal–*Mukuram;* Mar–*Sundrichand;* Tam–*Chomuntri;* Tel–*Adavibaadamu;* Andamans–*Mawtda*).	Small to medium, evergreen tree.	Coastal forests of India and the Andamans in mangrove forests.	Suitable for estuarine areas. Timber employed in building boats, canoes, ships, etc. Yields good fuel with high calorific value. Twig used as tooth-brush. Seed edible; contains tannin and fatty oil; decoction given for diarrhoea and dysentery.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
H. minor Lam. syn. *H. fomes* Buch.-Ham. (Beng & Oriya–*Sundri*; TRADE–*Sundri*).	Small, evergreen tree, with buttressed stem.	Deltaic regions of the Ganga, Brahmaputra and Mahanadi; more common in Sundarbans; found in fresh-water and salt-water forests, with heavy rainfall.	Suitable for estuarine areas. Can be cultivated on saline soils also. Timber used for boat-making, furniture, etc. Yields fuel (sapwood, 5028 kcal; heartwood, 5261 kcal/kg) and good-quality charcoal. Leaf edible; leaf (9.7–11.7%) and bark (8.0–12.4%) yield tannins. Seed may be eaten.
Hydrocotyle javanica Thunb. (*Hydrocotylaceae*).	Prostrate herb. *Fl. & Fr.:* May–October.	Throughout the Himalayas and Assam hills, at 600–2400 m and on western ghats from Uttara Kannada southwards.	Useful soil-binder; may be grown in plantations of coconut and rubber. Herb cooling, alterative and diuretic; used in cutaneous diseases; possesses insecticidal properties. Leaf blood-purifier and given in indigestion; also fish-poison. Leafstalk pungent, used in toothache.
Hydrophylax maritima Linn.f. (*Rubiaceae*).	Creeping, succulent herb, several metres long, rooting at nodes.	Found in coastal regions of India and on sand-hills.	Good soil-binder.
Indigofera cordifolia Heyne ex Roth (*Fabaceae*) (Bombay–*Godadi;* Gwalior–*Nilabari;* Rajasthan–*Vekriavas*).	Diffusedly branched, annual. *Fr.:* November.	Throughout India, found growing as lithophyte on eroded rocky surfaces and in mixed xeromphic thorny forests.	Useful forage plant of sand-dunes and saline and alkaline soils; can be grown on eroded rocky surfaces. Fixes nitrogen.

I. endecaphylla Jacq. (TRAILING INDIGO).	Annual or biennial trailing herb.	Hills of Deccan, western ghats and the Nilgiris, up to 1800 m. Prefers clayey soil but grows on sandy or sandy-loam soils and in coastal regions. Drought-resistant. Withstands pruning.	Tolerates acid and phosphorus-deficient soils. Provides excellent cover in protecting sandy or sandy-loam soils from erosion, especially in plantations of tea, coffee and rubber. Used as green manure. Fixes nitrogen. Readily eaten (protein, 4.1%) by cattle. Leaves and stems rich in vitamin-A and -C.
I. linifolia (Linn. f.) Retz. (Beng & Mar–*Bhangra;* Guj–*Jhinkigali;* Hindi–*Tokri;* Delhi–*Leel;* Santal–*Tandikhodebaha*).	Prostate or suberect, pubescent, annual.	Throughout India. Gregariously prostrate on sand; but among grasses and dense vegetation becomes erect.	Suitable for arid regions of Rajasthan and saline and alkaline soils. Fixes nitrogen. Suitable for fodder. Seed eaten during famine.
Many other *Indigofera* spp also fix nitrogen.			
Iseilema laxum Hack. (*Poaceae*) (Hindi–*Mushan;* Mar–*Champe;* Oriya–*Pandasuali;* Tam–*Thenganaripillu;* Tel–*Errachengaligaddi;* M P–*Bharwan;* Punjab–*Champ*).	Tufted, perennial up to 90cm. *Fl. & Fr.*: September–December.	Almost throughout India, up to *c*1000 m, usually on low-lying, waterlogged situations, but gregarious on loamy, clayey and black cotton-soils in Andhra Pradesh. Fairly drought-resistant. Withstands cutting. Through seed.	Suitable cover for protecting earthen banks, waterways and trenches from erosion. Best fodder (crude protein, 5.67%) and relished by cattle and horses in green state and as hay. Ongole cows are fed with this grass.
I. prostratum Anderss. syn. *I. wightii* Anderss. (Mar–*Achigrass, gandel;* Tel–*Yerrakalakasuva;* M P–*Buri;* Punjab–*Gauni;* U P–*Gandel*).	Tall, tufted, perennial, up to 1.2 m, rooting at nodes.	Almost throughout India in damp and swampy places. Grows on heavy and light soils but prefers black cotton-soils.	Can be grown on coastal saline soils. Fair fodder (crude protein, 4.58%) up to flowering; makes a fine hay.
Juglans regia Linn. (*Juglandaceae*)	Deciduous, monoecious	Throughout the Himalayas and	Recommended for cold deserts for

Species/Family/Names	Characters	Distribution/Propagation	Utilization
(COMMON WALNUT; TRADE-*Walnut; akhrot*).	tree, with tomentose shoots. *Fl. & Fr.*: September–October.	hills of Assam, at 900–3300 m. Occurs as pure crop or in mixture with other broad-leaved species of conifers. Grows on poor soils, terraces or near dwellings. A light-demander; coppices well. Through seed and transplanting.	reclamation, and for social forestry; can be grown as shelterbelts. Timber good for furniture, cabinet-making, musical instruments, inlay and other ornamental work. Oilcake rich in protein (35%) and eaten; also given as cattle-feed. Twig and leaf lopped for fodder. Leaf rich in ascorbic acid and carotene; yields a tea-flavoured volatile oil (0.012–0.029%). Bark (7.51%) leaf (9.11%) and hull (12.23%) yield dye and tannins; bark used for cleaning teeth and reddening gums and lips. Immature fruit also rich in ascorbic acid. Kernel edible; yields an edible oil (60–70%); used for making oil-colours, printing-inks, varnishes and soap. Shell-flour used as fillers.
Kandelia candel (Linn.) Druce syn. *K. rheedii* Wight ex Arn. (*Rhizophoraceae*) (Beng–*Goria;* Kan–*Kandale;* Mal–*Cerukandal;* Oriya–*Rasunia;* Tam–*Thuvar–kandan;* Tel–*Kandigala*).	Evergreen shrub or a small tree.	Found in the coastal forests of India, usually in muddy swamps and tidal creeks.	Recommended for planting along the sides of backwaters and for estuarine areas; used as green manure. Timber used as fuel and for charcoal. Bark rich in tannins (15.4–17.3%);

			used for tanning and dyeing. Used along with dry ginger or long pepper and rosewater in diabetes.
Khaya senegalensis A. Juss. (*Meliaceae*) (DRY-ZONE MAHOGANY).	Deciduous, savannah tree, up to 25 m/ 3.2 m.	Introduced into Indian Botanic Garden, Calcutta.	Suitable for the reclamation of mined wastelands. Timber used for coach-work, and furniture.
Kochia indica Wight (*Chenopodiaceae*) (Hindi & Punjab–*Kaurarobui*).	Erect, soft, vigorous, hairy herb. *Fl. & Fr.*: March-November.	Found in North-West India, and peninsular region in the irrigated, saline soils. Through seed.	Thrives well in African deserts; may be tried in the desert-region of Rajasthan; grows on saline soils. Can be grown on canalbanks, roadsides, etc. Dried plant used as fuel. Relished by camels,cattle and mules. Used as a cardiac stimulant.
K. prostrata Schrad.	Villously pubescent, undershrub, with woody rootstock.	In the dry regions of Kunawar and Zanskar, at 3000–5200 m; characterstics of semi-desert and desert areas.	Useful for reclaiming the cold deserts. Affords good fodder (crude protein, 9.8%).
K. scoparia Schrad.	Tall, erect herb, up to 1.5 m.	Found in North-West India. Resistant to drought.	May be useful for reclamation. Eaten by cattle (crude protein, 18.7%) but not by grasshoppers.
Kummerowia stipulacea Makino syn. *Lespedeza stipulacea* Maxim. (*Fabaceae*) (KOREAN LESPEDEZA).	Annual herb.	Introduced from the USA.	Useful for erosion-control. Used as green manure. Fixes nitrogen. Valuable green fodder and hay.
K. striata Schindl. syn. *L. striata* Hook. & Arn.; *Microlespedeza striata* Makino	–	–	Fixes nitrogen.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Kydia calycina Roxb. (*Malvaceae*).	Small or moderate-sized, fast-growing, deciduous tree, up to 13m/up to 1.3/m.	Throughout the greater part of India, chiefly in mixed deciduous forests but not in arid areas; common in the sub-Himalayan tract. A light-demander. Fairly drought- and frost-hardy. Coppices well. Pollards satisfactorily and produces root-suckers. Through seed, transplanting and stump.	Suitable for semi-moist areas and can be grown on grassy blanks. Timber used for building construction, pulp and for various other articles; used as fuel (5063 kcal/kg). Leaf lopped for fodder. Bark yields fibre.
Lablab purpureus (Linn.) Sweet syn. *Dolichos lablab* Linn. (*Fabaceae*) [var. *typica* (LABLAB-BEAN, INDIAN BUTTER-BEAN; Beng–*Shim;* Guj–*Val;* Hindi–*Sem;* Kan–*Chapparadaavare;* Mal & Tam–*Avarai;* Mar–*Pavta;* Tel–*Chikkudu*); var. *lignosus* Prain (FIELD-BEAN; Guj–*Val;* Hindi–*Ballar;* Kan–*Avare;* Mal–*Mochakotta;* Tam–*Mochai;* Tel–*Anumulu*)].	Climbing herb.	Cultivated throughout India. Hardy and drought-resistant; and adapts to dry areas. Through seed.	Useful for conservation of saline and sandy loam and coastal region; and also used as a green manure. Fixes nitrogen and a potential renovator of dry areas. Pod used as vegetable; seed eaten as pulse.
Lagerstroemia duperreana Pierre ex Gagnep. syn. *L. thorelii* Gagnep. (*Lythraceae*).	Small tree.	–	Recommended for social forestry.
L. hypoleuca Kurz (Andamans–*Pyinma;* TRADE–*Andaman Pyinma*).	Large tree, up to 21 m/up to 3 m.	Deciduous and evergreen forests of Andamans. Through seed.	Useful for reclaiming water logged areas; suitable for social forestry on low ground and sandy soil. Timber useful for buildings and furniture.

L. lanceolata Wall. (Kan–*Benteak;* Mal–*Velillavu;* Mar–*Nana;* Tam–*Vevala;* Tel–*Ventaaku;* TRADE–*Benteak, nana*).	Medium to large deciduous tree, up to 30 m/up to 3 m.	Bombay southwards to Kerala; also on the hills of Deccan Peninsula, up to 1200 m. Best development in the regions of heavy rainfall. Through seed.	Suitable for reclaiming water-logged areas and crystalline rocky to laterite soils. Timber suitable for buildings and commercial plywood. A good fuel.
L. speciosa Pers. syn. *L. flos-reginae* Retz.; C.B. Clarke (Fl Br Ind) in part (PRIDE-OF-INDIA, QUEEN CRAPE-MYRTLE; Beng, Hindi–Punjab–*Jarool;* Kan–*Holedasavala;* Mal–*Manimaruthu;* Mar–*Taman;* Oriya–*Patoli;* Tam–*Kadali;* Tel–*Varagoogu;* Assam–*Thing-douthlado;* TRADE–*Jarool*).	Deciduous tree, up to 24 m/up to 3.6 m.	Throughout India. Through seed and transplanting.	Suitable for waterlogged areas and for planting along banks of rivers and streams, and in lowlying swampy areas; recommended for mine-workings, agro- and social forestry. Timber moderately durable and used for buildings.
Lannea coromandelica (Houtt.) Merrill syn. *L. grandis* Engl.; *Odina wodier* Roxb. (*Anacardiaceae*) (Beng–*Jiyal;* Guj–*Mavedi;* Hindi–*Jhingan;* Kan–*Ajasringi;* Mal–*Odiyamaram;* Mar–*Moi;* Oriya–*Indramai;* Tam–*Wodier;* Tel–*Appriyada;* Andamans–*Nanum;* Assam–*Jia;* Lepcha–*Dang-paguel-kung;* Rajasthan–*Gobi;* TRADE–*Wodier, jhingan*).	Medium to large, deciduous tree, up to 24 m.	Throughout the greater part of India, up to 1500 m in Himalayas, and also Andamans; grows on sand-stone, limestone, and metamorphic rocks, traps and sometimes laterite. A light-demander. Fairly drought- and fire-resistant. Coppices and pollards well. Produces suckers. Through seed, transplanting and rootsuckers.	Suitable to grow on saline blanks; recommended for outer rocky hilly areas and dry, waste places and for social forestry. Timber used for buildings and furniture. A good fodder. Bark exudes a gum, used for clarification of sugarcane juice. Yields a fibre.
Lasiurus hirsutus (Forsk.) Boiss. syn. *Elionurus hirsutus* Munro ex Benth. (*Poaceae*) (Punjab–*Sin, sewan;* Rajasthan–*Shin-wan, siwan*).	Tufted perennial, often appearing almost shrubby, up to 90 cm. *Fl. & Fr.:* Almost throughout the year.	Occurs in the sandy areas of Punjab and Rajasthan. Forms extensive pastures for considerable area. Through seed and rhizomatous rootstock.	Suitable for sandy deserts to stabilize sand. Good, nutritious desert-fodder; good for grazing when young. Mature grass used for thatching.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names.	Characters	Distribution/Propagation	Utilization
			Seed used as food in admixture with *bajra*. Root-fibre used for weaver's brushes.
L. sindicus Henr. (Rajasthan–*Sevan grass*).	Perennial, tussocky grass.	Found in North-West India. Grows in large, bushy thickets in sandy deserts with deep-penetrating root-system, up to 4 m and horizontal spread of 6 m. Extremely drought-resistant; most suitable for 125–300 mm rainfall zone.	Suitable for loose sandy soil; can be cultivated even in consolidated sandy loam soils; also useful for grass- and rangelands.
Lawsonia inermis Linn. syn. *L. alba* Lam. (*Lythraceae*) (HENNA; Beng–*Mehedi;* Guj–*Medi;* Hindi, Mar & Punjab–*Mehndi;* Kan–*Mayilanchi, goranta;* Mal–*Mailanchi;* Oriya–*Benjati;* Sans–*Mendika;* Tam–*Marithondi;* Tel–*Gorinta;* Kashmir–*Mohuz;* Mundari–*Mindi*).	Branched shrub, up to 5 m.	Tropical and temperate regions; commonly cultivated in some parts. Through seed and cutting.	Suitable for low-alkaline soils and heavy soils such as black cotton; also grows on several other soils; a useful hedge. Leaf commonly used for colouring palms, fingers and feet.
Leptadenia pyrotechnica (Forsk.) Decne syn. *L. spartium* Wight (*Asclepiadaceae*) (Guj & Punjab–*Khip;* Rajasthan–*Khimp*).	Much-branched, often leafless shrub, up to 1.8 m. *Fl. & Fr.*: June–December; September–March.	Grows in dry, arid and sandy places, and also on eroded rocky surfaces in Punjab, Uttar Pradesh, Rajasthan and northern parts of Bombay along seacoast.	Suitable for reclamation of dry, sandy, eroded rocky areas. Provides fodder for cattle, horses and camels. Tuberous root, slimy fruit and young twig used as food. Plant yields a fibre, used for rope-making and paper.

Leptochloa chinensis Nees (*Poaceae*) (Hindi–*Chanhel;* Kan–*Kaadus-annakarisajaiihullu;* Tam–*Aeripul;* Tel–*Cheepurugaddi*).	Erect annual, up to 1.2 m.	Throughout India; luxuriant in moist areas.	Can be grown along watercourses. Yields good fodder (protein, 9.57%).
L. panicea (Retz.) Ohwi syn. *L. filiformis* Hook. f. (Fl Br Ind), non Beauv.; *L. contracta* Blatter & McCann).	Erect annual, with slender stems, up to 60 cm.	Throughout India, up to 600 m in moist situations.	Can be grown near canals and ponds. Grazed when young (protein, 6.73%).
Leptothrium senegalensis (Kunth) W.D. Clayton syn. *Latipes senegalensis* Kunth (*Poaceae*).	Small, short-lived, perennial grass, up to 60 cm, with wiry creeping stems. *Fl. & Fr.*: January–March.	Desert of Rajasthan. Through seed.	Can be grown to stabilize soil in desert and for saline soils. Good fodder in sub-desert regions. Seed reported to be used as food.
**Limonia acidissima* Linn. syn. *Feronia limonia* (Linn.) Swingle; *F.elephantum* Corrêa (*Rutaceae*) (ELEPHANT-APPLE, WOODAPPLE; Beng & Hindi–*Kait;* Guj–*Kavit;* Kan–*Bela;* Mal–*Vila;* Mar–*Kavatha;* Tam–*Vilanga;* Tel–*Velaga*).	Small, deciduous tree, up to 12 m, with short, erect, cylindrical stem.	Throughout the plains of India, particularly in dry situations. Also cultivated on borders of fields and as a roadside tree. Can be planted on almost all kinds of soils and climate. Through seed, cutting and layering.	Recommended for ravines, semi-arid areas, and for social forestry. Timber for agricultural implements and ornamental carving. Leaf lopped for fodder. Fruit-pulp acidic; used as a vegetable, for chutneys and sherbets; refreshing tonic, astringent and alexiformic. Bark exudes a gum.
Lolium perenne Linn. (*Poaceae*) (PERENNIAL RYEGRASS).	Perennial grass, up to 90cm, with tufted stems.	Found in western Tibet, at 4500 m, introduced into Shimla and Kangra valley in Himachal Pradesh, Sikkim, (2100 m), Shillong, Nilgiri and Palni hills; tried at the lower foothills, valleys	Recommended for cold desert; tolerant to boron. Grows on urban wastelands, coal-spoils and flyash. Excellent fodder, valuable as pasture, ley or sward, but exclusive feeding may cause

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*Some consider it nomen confusum and treat under *Feronia limonia.*

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
		and highlands of South India. Responds well to cultivation and manuring and can be grown in mixture with clover and other grasses.	diseases.
Lopholepis ornithocephala (Hook.) Steud. (*Poaceae*).	Erect perennial herb.	Southern India, in sandy areas.	Useful for fixation and reclamation of sand-dunes, and for coastal saline soils.
Lotus corniculatus Linn. (*Fabaceae*) (BIRDSFOOT TREFOIL).	Perennial herb, up to 30 cm, with slender glabrous stem. *Fl. & Fr.:* February–October.	Western Himalayas; hardy and shows a wide range of adaptability to climatic and edaphic conditions. Tolerant to drought and high concentration of salt.	Good soil-binder; may be suitable for slimes. Fixes nitrogen. Good pasture (protein, 5.6%) plant; can be fed as silage or hay (protein,14.2%); a good source of carotene.
Maytenus emarginata (Willd.) Ding Hou syn. *Gymnosporia montana* (Roth) Benth.; *G. spinosa* (Forsk.) Fiori; *Celastrus montanus* Roth;? *G. senegalensis* Loesl. (*Celastraceae*) (Beng–*Vaichigachha;* Guj–*Vikalo;* Hindi–*Vingar;* Kan–*Tan drasi;* Mar–*Yekaddi;* Oriya–*Gourokosa;* Tam–*Kattanji, valuluvai;* Tel–*Danti, peddachintu;* Bombay–*Hurmacha;* Punjab–*Mareila;* Rajasthan–*Kangkera*).	Much-branched, spinescent shrub or a small tree, up to 5 m. *Fl. & Fr.:* August–December.	Throughout the drier parts of India. Found in deciduous and xeromphic forests and in arid regions of Rajasthan; also in Madhya Pradesh. Through direct sowing.	Can be grown for afforestation in dry, rocky soils, or rocks covered with sand and sand-dunes in arid regions. Timber used for making beads. Ash used as salt. Leaf decoction used as mouthwash.

Medicago hispida Gaertn. (*Fabaceae*) syn. *M. denticulata* Willd. (CALIFORNIAN BUDCLOVER; Beng, Hindi, Punjab & Delhi–*Maina*).	Annual, semi-erect or prostrate herb.	Punjab, Upper Gangetic Plain, North Bengal and parts of Tamil Nadu, up to 1500 m. Prefers slightly alkaline, loamy soil. Through seed.	Soil-renovator and useful winter-cover preventing erosion. Used as green fodder. Fixes nitrogen.
M. sativa Linn. (ALFALFA; LUCERNE; Guj–*Vilaytighas;* Hindi–*Lasunghas;* Kan–*Vilayatihullu;* Mar–*Vilyatigavat;* Ladakh–*Hol;* Punjab–*Lusan*).	Branched, perennial herb, up to 1 m. *Fl. & Fr.* July–December.	Cultivated throughout India on various kinds of soil with annual rainfall of 500–600 mm. Hardy and drought-resistant. Through seed.	Useful cover-crop. Suitable for social forestry, especially cold deserts. Prevents compaction of soil. Fixes nitrogen.
Melaleuca leucadendron Linn. (*Myrtaceae*) (CAJUPUT-TREE; Beng, Hindi & Mar–*Cajaputte;* Tam–*Kaiyappudai*).	Tree of moderate height, up to 21 m/up to 1.5 m.	Cultivated as ornament in gardens and parks. Widely occurs in swamps and low-lying areas. Through seed or cutting. Artificially sown seed do not germinate; self-sown seedling common around the trees.	Recommended for reclamation of saline and acid soils and mined sites. Timber useful for ship-building, posts and piles. Fresh twigs and leaves yield a volatile, medicinal oil, CAJUPUT OIL; used as mosquito-repellent. Bark substituted for cork.
Melanocenchris jacquemontii Jaub. & Spach syn. *M. royleana* Nees; *Gracilea royleana* Hook. f. (*Poaceae*) (Hindi–*Phulsi;* Bombay–*Guli, bedari, dongri*).	Slender, densely tufted annual, up to 20 cm. *Fl. & Fr.:* August–October.	Nearly throughout India, fairly common in sandy, stony or barren ground; grows in the most inhospitable habitats, such as cracks in rocks in full sunlight. Through seed.	Suitable for the reclamation of sandy, stony, rocky and barren ground. Grazed by cattle when young.
Mesembryanthemum crystallinum Linn. syn. *Cryophytum crystallinum* (Linn.) N.E. Br. (*Aizoaceae*) (ICEPLANT).	Much-branched, prostrate, succulent annual, up to 60 cm. *Fl. & Fr.:* January–April.	Cultivated in Indian gardens; grows on sandy areas and salty deserts. Through seed or cutting.	Grown on the seacoast and salty deserts to remove excess salts from soil. Recommended for reclaiming saline areas of Punjab.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
			Leaf eaten as spinach and salad. Seed edible.
Mimosa hamata Willd. (*Mimosaceae*).	–	–	Grown as hedge-plant; may be useful for green-manuring. Fixes nitrogen. Browsed by cattle (protein, 11.87%).
M. himalayana Gamble syn. *M. rubicaulis* Baker (Fl Br Ind) in part, *non Lam. (Beng & Hindi–*Shiah-kanta;* Tel–*Koodimudusu;* Assam–*Kaurikanta;* Bihar–*Khirlachikanta;* Garo–*Remsum;* Kumaun–*Khinkari;* Mikir–*Ingsumaha;* Punjab–*Deokhadia*).	Erect or straggling shrub, up to 3 m. *Fl. & Fr.*: July–September; November–January.	Throughout India, up to 1000 m in outer Himalayas. Common along watercourses, heavily grazed scrub forests and abandoned cultivated lands.	Suitable for cultivation on mine wastelands and as hedge. Timber used for tentpegs and gunpowder charcoal. Root, leaf and fruit may be medicinally useful.
M. pudica Linn. (SENSITIVE PLANT; TOUCH-ME-NOT; Beng–*Lajjabati;* Hindi–*Lajawanti;* Kan–*Lajja;* Mal–*Tintarmani;* Mar–*Lajalu;* Oriya–*Lajkuri;* Tam–*Tottalvadi;* Tel–*Attapatti, peddanidrakanni;* Assam–*Nilajban;* Khasi–*Kambatsamthai;* Mundari–*Durum-junum*).	Diffuse undershrub, clothed, up to 90 cm, with long bristles from bulbous bases. *Fl. & Fr.*: August–October; November–December.	Native to tropical America, introduced into India, almost naturalized throughout India. Common in waste places; also a trouble some weed.	Suitable for growing in waste places. Fixes nitrogen. Used as pasture in Fiji; withstands heavy grazing. Tender plant (flowering-tops: protein, 5.5%) readily eaten by cattle, produces firm flesh and increases flow of milk. Leaf-paste applied to glandular swellings; juice used for sores and piles. Pod poisonous to horses, chicks and birds. Seed yields an oil like soyabean oil with similar uses.

M. rubicaulis Lam.; Baker (Fl Br Ind) in part is considered to be found only South of Godavari.

M. scabrellae Benth.	–	Native to Brazil, successfully introduced into North-eastern hills of India.	Introduced to grow on hills for afforestation and reclamation. A fair nitrogen-fixer. Yields a good fuel and fair timber.
Mitragyna parvifolia (Roxb.) Korth. syn. *Stephegyne parvifolia* Korth. (*Naucleaceae*) (Beng–*Gulikadam;* Guj–*Kadamb;* Hindi–*Kaim;* Kan–*Kongu, kodaga;* Mal–*Vimbu, nirkadambu;* Mar–*Kalamb;* Oriya–*Gudikaimo;* Tam–*Chinnakadambu;* Tel–*Neeirukadambe;* TRADE–*Kaim*).	Medium to large, deciduous tree.	Throughout the greater part of India, up to 1200 m, on low-lying areas around banks and swamps. A light-demander. Fairly drought-hardy. Tolerates stiff and badly drained ground, black cotton-soil and alluvial ground near rivers. Coppices well. Through seed.	Useful for reclamation of brackish-water areas. Timber commonly used as planks and rafters, in building construction, furniture, agriculture implements and shuttles. Leaf used as fodder (crude protein, 7.73%); rich in tannins. Bark and root used for fevers and colic; bark yields a fibre.
Mundulea sericea Cheval. syn. *M. suberosa* Benth. (*Fabaceae*) (Kan–*Bettahuruli, kadutuvara;* Mal–*Kattutuvara;* Tam–*Pilavram;* Tel–*Kondavempali, verribilludu*).	Stout, erect shrub or a small tree, up to 4.5 m. *Fl. & Fr.:* May–June.	Almost throughout India in dry forests and on rocky hills, up to 1200 m. Freely coppices. Through seed.	Useful plant for afforesting bare hills. Fixes nitrogen. Plant possesses insecticidal and piscicidal properties.
Myriostachya wightiana (Nees ex Steud.) Hook. f. (*Poaceae*).	Stout, densely tufted perennial herb, up to 3 m, with thick and spongy rootstock.	South India and West Bengal; on coasts and in mud of tidal rivers just at high watermark. Through seed and rootstock.	Useful colonizer of coastal flats.
**Narenga porphyrocoma* (Hance ex Trin.) Bor syn. *Saccharum narenga* Wall. (*Poaceae*) (Assam–*Bata, ronsa;* U P–*Ganeria, tanwar*).	Slender, perennial grass, up to 2.5 m, with stout rhizome.	From Garhwal to Assam and in Orissa at 900–1200 m. Common and widely distributed savannah grass of *sal* forests; valuable indicator of soil moisture. Through seed.	Good soil-binder. Young and immature leaves brówsed by cattle. Culms used for thatching, rough mats and screens.

* Some treat it as synonym of *Saccharum narenga* Wall.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Nelumbo nucifera Gaertn. syn. *Nelumbium nelumbo* Druce; *N. speciosum* Willd. (*Nymphaeaceae*) (SACRED LOTUS, INDIAN LOTUS, CHINESE WATERLILY; Beng–*Padma;* Hindi–*Kanwal, kamal;* Guj–*Suriya-kamal;* Kan–*Kamala, tavaregadde;* Mal–*Senthaamara;* Mar–*Kamal;* Oriya–*Padmo;* Sans–*Ambujam, padmam, pankajam, kamalam;* Tam–*Ambal, thamarai;* Tel–*Erarkaluva; errataamara;* Assam–*Podum;* Kashmir & Punjab–*Pamposh;* Khasi–*Soh-lapudong;* Mundari–*Kombolba*).	Perennial water-plant, with stout, creeping rhizome.	Throughout India in ponds, tanks and lakes, up to 1800 m. Cultivated in marshy land. Through seed and rhizome.	Recommended for cultivation on marshy land. Rhizome used as a vegetable, and yields a kind of arrowroot. Young leaf and petiole also eaten as vegetable. Leafstalk yields a fibre. Torus along with seeds eaten.
Neptunia oleracea Lour. syn. *N. prostrata*.Baill. (*Mimosaceae*) (Beng–*Paninajak;* Hindi & Punjab–*Lajalu;* Mal–*Nittitoddavaddi;* Tam–*Sadai, sundaikkirai;* Tel–*Neeruthalavapu;* Bombay–*Panilajak*).	Annual, floating, aquatic herb.	Throughout the greater part of India. Found in marshes, flooded paddy-fields, sides of tanks, lakes and other stagnant waters. Through seed.	Recommended for growing in marshy wasteland. Fixes nitrogen. Young ends of the stem eaten as potherb. Pod sometimes used as vegetable. Possesses refrigerant and astringent properties.
Neurada procumbens Linn. (*Neuradaceae*) (Rajasthan–*Chapari*).	Woody, tomentose annual. *Fl. & Fr.:* October–December.	Common plant on sand-dunes in arid regions of Rajasthan. Through seed and germination occurs in the carpels.	Can be grown on sand-dunes for stabilization. Used as fodder. Very strong tonic.
Neyraudia arundinacea (Linn.) Henr. syn. *N. madagascariensis* Hook.f.	Tall, perennial, leafy grass, up to 2.5 m.	Punjab to Bihar, Northern Bengal, Assam and Kerala, up to 1800 m.	Binds soil and may be grown for anti-erosion. Animals eat fresh,

(*Poaceae*) (UP–*Bicchroo, bansi*).			young shoots.
Nymphaea alba Linn. (*Nymphaeaceae*) (EUROPEAN WHITE WATERLILY; Kashmir–*Kumud*).	Perennial aquatic, herb.	Kashmir.	Uses same as for *N. nouchali*.
N. nouchali Burm.f. syn. *N. pubescens* Willd.; *N. lotus* Hook. f. & Thoms., non Linn.; *N. rubra* Roxb. ex Salisb. (INDIAN RED WATERLILY; Beng–*Rakto-kambal;* Guj & Hindi–*Kanval;* Kan–*Nyadalehuvu;* Mal–*Periambal, neerambal;* Mar–*Lala- or raktu-kamal;* Oriya–*Dhabalokoin;* Tam–*Allitamarai, vellambal;* Tel–*Tellataamara, tellakaluva;* Assam–*Nal;* Mundari–*Pundis-alukid;* Punjab–*Chota kanwal*).	Large, aquatic herb, with short, erect, roundish, tuberous rhizome.	Throughout the warmer parts of India, in lakes, tanks, ponds and ditches.	Recommended for cultivation on marshy lands. All parts are eaten; floral stalk and unripe fruit used as vegetable; rhizome (crude protein, 5.87%) also eaten. Seed (crude protein, 7.98%) eaten raw or after parching; also ground into flour. Rhizome demulcent and used for dysentery and dyspepsia.
N. stellata Willd. (INDIAN BLUE WATERLILY; Beng, Guj & Hindi–*Nil-padma, ailkamal;* Mal–*Sitambel;* Mar–*Krishna-kamal;* Oriya–*Subdikain;* Tam–*Karuneythal;* Tel–*Nallakaluva, Neelikaluva, Neelitaamara;* Punjab–*Bambher, nilpadam;* Delhi–*Chottakamal*).	Large, perennial, aquatic herb, with a short rootstock.	Throughout the warmer parts of India; also cultivated for food in marshy places.	Uses same as for *N. nouchali*.
Nymphoïdes cristatum (Roxb.) Kuntze syn. *Limnanthemum cristatum* Griseb. (*Menyanthaceae*) (Beng–*Panchuli;* Hindi–*Tagarmul;* Mar–	Aquatic herb, with floating stem, rooting at nodes. *Fl. & Fr.:* Flowers throughout summer.	Almost throughout India; common in fresh-water lakes, tanks, ditches and ponds. Through seed.	Recommended for cultivation on marshy lands. Stem, leaf and fruit eaten either in curry or after boiling. Shoots

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Kolarechikal; Tel–*Antharataamara;* Bombay–*Khatara, kunnudim;* Mundari–*Marang chotam ara ba*).			pounded with oil and applied to ulcers and insect-bites; decoction used as a wash for parasitic affections. Plant is a substitute for *chirata* in fevers and jaundice.
N. indicum (Linn.) Kuntze syn. *L. indicum* Thw. (Hindi–*Bara chuli;* Mal–*Chinnambal;* Mundari–*Sadom lachomkor ba*).	Aquatic herb, with thick rhizome and stouter stolon.	Throughout India, in tanks, ponds and ditches.	Suitable for growing in ponds and ditches. Used as vegetable and in fever.
Nypa fruticans van Wurmb. (*Arecaceae*) (NIPA-PALM; Beng–*Gulga, gabna, golphal* (fruits); *golpatta* (leaves); Guj–*Pardeshi-tadio;* Andamans–*Poothada*).	Prostrate palm, with a stout, branched, creeping rhizome.	Tidal swamps of Sundarbans and in the Andaman; also recorded from Saurashtra. Grows best in alluvial deposits of clayey loam with sufficient salt. A light-demander. Through seed and rhizome.	Gregariously grows in mangrove swamps and tidal forests. Useful for stabilizing soil. Much valued for the sweet sap which may be used for making jaggery, alcohol and vinegar. Tender stem and bud eaten. Leaf used for thatching, etc. and yields a fibre and tannins (10.2%).
Nyssa sylvatica Marsh syn. *N. multiflora* Wang. (*Nyssaceae*) (BLACK TUPELO).	Tall tree.	Native to North America, introduced into India. Through vegetative reproduction.	Recommended for polluted and burnt areas. Timber used for boxes, rollers and paperpulp.
Opuntia dillenii Haw. (*Cactaceae*) (PRICKLYPEAR; Beng & Hindi–	Erect, spiny, succulent shrub, up to 2 m, with leaf	Wild almost throughout India, particularly South. Grows on	Recommended for all types of soils from swampy to arid regions.

Nagphana; Kan–*Papaskalli;* Mal–*Palakakkalli;* Mar–*Chapal;* Oriya–*Nagophenia;* Tam–*Nagathali;* Tel–*Nagajemudu, bommajemudu*).	modified into horn-coloured spines on each areole, and stem into cladode.	the poorest and driest of soils; needs very little water. Through seed and more commonly stem-cutting.	Spines give protection to the plant as well as to the seedlings of other species which grow near it. A good fertilizer. Despined and used as fodder. Plant yields a coarse fibre used for pulp; possesses antibiotic activity. Fruit eaten; useful in whooping-cough.
O. elatior Mill. syn. *O. nigricans* Haw.	Large, succulent shrub, with leaf modified into 2–5 spines in each areole and stem cladode.	Almost throughout India, found wild.	Grows on several soils and recommended for erosion-control. Planted as hedges; used as green manure; also as fodder after removing spines. Fruit edible. Used as *O. dillenii.*
O. vulgaris Mill. syn. *O. monocantha* Haw.	Large, succulent shrub, phylloclade reaching 2 m.	Wild throughout India.	Grows on various soils and abandoned sites and rocky areas. Useful for reclaiming such soils. Spines give protection not only to plant but to other seedlings. Extract of cladode possesses anti-haemorrhagic activity. Flower yields a flavonoside (2%) which inhibits capillary fragility. Fruit edible. Seed yields an oil (8.9%).
Orinus thoroldii (Stapf ex Hemsl.) Bor syn. *Diplachne thoroldii* Stapf ex Hemsl. *(Poaceae).*	Erect, slender, glabrous, perennial, up to 50 cm, with hard, scaly, creeping rhizomes.	Kashmir, at high altitudes in dry, and sandy habitats.	Good sand-binder and stabilizer of shifting sands. When green, animals may graze upon it.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Oryzopsis hymenoides (Roem. & Schult.) Ricker ex Piper (*Poaceae*) (INDIAN RICE-GRASS).	Erect grass, up to 60 cm.	Introduced from the USA; common in dry,sandy places.	Recommended for cultivation on mine-sites. Seed eaten.
Oxalis corniculata Linn. (*Oxalidaceae*) (INDIAN SORREL; Beng & Hindi–*Amrul sak*, Kan–*Hulichikkai;* Mal–*Puliyarel;* Mar–*Ambuti, anjatii;* Tam–*Puliyarai;* Tel–*Pulichinta;* Kumaun–*Amelda;* Lushai–*Siakthur;* Mundari–*Pirijojo;* Santal–*Tandichatomarak*).	Small, erect annual or perennial, up to 25 cm, with tubers.	Throughout the warmer parts of India, up to 3000 m. Common weed in cultivated and waste-lands, particularly in moist and shady localities. Through small underground tubers.	Controls soil-erosion in tea-estates and difficult to eradicate; also used as a green manure. Leaf eaten raw as salad and potherb; rich source of vitamin-C. Leaf appetizing, anti-scorbutic and antibilious.
O. latifolia H. B. & K. (Delhi–*Khatmitthi;* Oran–*Unk arxa*).	Perennial, stemless herb, up to 25 cm, with bulbs.	Native to Mexico, found from North-West Himalayas, Chota Nagpur, Assam to peninsular India.	Considered an efficent soil-cover in tea-estates; can be used as green manure. Plant soporific.
O. corymbosa DC. *O. martiana* Zucc. syn. (Tam–*Periapuliyarai;* Delhi–*Khatmitthi;* Lakhimpur–*Tengasetenga*).	Perennial herb, up to 25cm.	Native to America, naturalized in moist and shady places including Delhi, Mungpoo and Dibrugarh in eastern India, and Shevaroy and Palni hills in South India.	Useful check for soil-erosion on steep slopes; a very good green manure. Pleasant-flavoured tubers eaten.
Paspalum conjugatum Bergius (*Poaceae*) (BUFFALOGRASS).	Annual or perennial stoloniferous grass, up to 60 cm.	Assam, West Bengal, Karnataka and Kerala.	Useful for preparing lawn and may be useful to prevent erosion. Valuable fodder (protein, 2.9%) before seeding; contains carotene and ascorbic acid. Plant-extract possesses haemostatic property.

P. dilatatum Poir. (DALLIS-GRASS).	Strongly tufted, perennial, up to 1.5 m, with thick, strong rootstock.	Native to South America, introduced and established as a pasture in all hill-stations. Best adapted to humid subtropical climate; thrives best on moist, heavy soils. Winter-hardy.	Suitable for erosion-control. Yields nutritious forage (protein, 3%); can be converted into silage and hay (protein, 9.4%); a good source of carotene, ascorbic acid, and also iodine.
P. notatum Fluegge (BAHIA-GRASS).	Slow-growing, deep-rooted perennial.	Native to Central and South America. Drought-resistant; remains green throughout the year.	Valuable as a soil-binder. Highly salt-tolerant. Can be used for pasture, persists under grazing and trampling.
P. scrobiculatum Linn. syn. *P. commersonii* Lamk. *P. scrobiculatum* var. *commersonii* Stapf & var. *frumentaceum* Stapf (KODOGRASS, KODOMILLET; Beng–*Kodoadhan;* Hindi–*Kodo;* Guj–*Kodro;* Kan–*Haraka;* Mal & Tam–*Varagu;* Oriya–*Kodus;* Tel–*Arikalu, varagulu*).	Annual, often tufted grass, up to 90 cm.	Probably native to South Africa, found throughout India, up to 1600 m. Thrives in moist places with moderate rainfall on a variety of soils, best being on loamy soils, Hardy. Drought-resistant.	Suitable for reclamation of ravines; and may also be for alkaline soils, as it resists alkalinity. Straw a good fodder (protein, 2.2%); used as manure. Young grass (protein, *c* 5%) eaten. Grain (whole: protein, 10.6%; husked: protein, 11.6%) cooked like rice and eaten.
P. vaginatum Sw.	Perennial grass, with creeping rhizome.	Sandy coasts of Maharashtra, Gujarat, Tamil Nadu and Andhra Pradesh.	Efficient sand-binder, and can be grown on coastal saline and metalliferous soils. Yields fodder.
Pennisetum clandestinum Hochst. ex Chiov. (*Poaceae*) (KIKUYU-GRASS).	Fast-growing, copiously branched, rhizomatous, perennial grass, up to 1.2 m, with deep root-system of 3 m.	Native to East Africa, introduced on the Nilgiris and Annaimalai hills and in Sikkim and Assam, up to 2100 m. Suitable for moist hilly situations, thriving best on deep, rich, well-drained, loamy soils.	Very valuable for soil-conservation of hill-slopes, bunds and sides of water-channels, and waterlogged areas. Can be cultivated on laterite soil. Makes excellent lawn and suffers nil from grazing or

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
		Remains green for most of the period of drought and persists. Frost-hardy. Remains dormant during the winter and appears in the spring. Through cutting of rootstock or runner.	trampling. Recommended for hill-pasture and for poultry as fowls eat the leaves. Palatable, nutritious fodder (protein, 5.1%); suitable for hay (protein, 10%) or silage.
P. hohenackeri Hochst. ex Steud. syn. *P. alopecuros* Nees ex Steud. (Kan–*Nosaihullu mannaigedde;* Tam–*Munjapillu*).	Coarse, erect perennial forming large tussocks, up to 2 m, with thick, tough roots.	Western India in Rajasthan, Central and southern India near streams and lakes or wet or marshy areas.	Extremely tough and sometimes occupies large patches of land. May be grown for erosion-control of sandy soil near streams and lakes. Useful for brooms and cordage.
P. mezianum Leeke	Perennial grass, with tussocks.	Introduced into India from Africa. Drought-resistant.	Suitable for arid regions.
P. orientale Rich.	Perennial grass, up to 1.8 m, with a powerful, woody rootstock sending out short, thick rhizomes, with coriaceous scales.	From Kashmir to Kumaun at 600–2400 m, Konkan and Bihar. Drought-resistant, and remains green throughout the year. Through rootstock.	A good soil-binder, recommended for stabilization of sand-dunes. Yields nutritive and palatable fodder (protein, 8.9%). Grain can be used in distillation.
P. pedicellatum Trin.	Annual grass, with much-branched stem, up to 1.5 m. *Fl. & Fr.:* August–January.	Almost throughout India in rocky places, often sub-gregarious. Drought-resistant.	Suitable for ruined sites in lateritic soils. Yields excellent green fodder and hay before flowering. Successful in mixtures.

Phacelurus speciosus (Steud.) C. E. Hubbard syn. *Rottboellia speciosa* Hack. (*Poaceae*).	Perennial, tufted grass, up to 1.5 m, with very stout rootstock.	From Kashmir to Garhwal, at 1500–3000 m.	Since the rootsystem is extremely extensive and tough, it may be useful in reclaiming badly eroded areas. Considered good fodder in dry hill-valleys above 1500 m.
Phalaris arundinacea Linn. (*Poaceae*) (REED CANARY-GRASS).	Robust, perennial, variable grass, with creeping rhizomes and erect stem.	Kashmir, at 1665 m.	Because of its strong rhizomes, considered useful in anti-erosion work; can be grown on sewage sludge for erosion-control. Useful for grazing when young (protein, 14.46%) or for hay (protein, 7.7%); can also be ensiled. Seed used as bird-feed.
P. aquatica Linn. syn. *P. tuberosa* Linn. and *P. minor* Retz. are also suitable to reclaim hills.			
Phaseolus atropurpureus Moc. & Sesse emend. Hassler (*Fabaceae*) (Hindi-*Siratro*).	Perennial, pasture-legume, with strong, stoloniferous and long taproot.	Native to Mexico and tropical America, introduced into Rajasthan; shown considerable promise as a drought-resistant fodder-legume.	May be useful for the control of erosion and for reclamation of wastelnds. Fixes nitrogen. Withstands hard and frequent grazing. Useful for pasture, up to 1800 m.
Phleum pratense Linn. (*Poaceae*) (TIMOTHY GRASS).	Medium-sized, tufted, erect perennial grass, up to 1.5 m.	Native to Europe and temperate Asia, found as an escape on the Himalayas at Shimla and in Meghalaya.	Recommended for growing on smelter waste. Yields a highly palatable and nutritious, important fodder (protein, 4.7%) and suitable for hay (protein, 9.7%); can be mixed with alfalfa. Extracts of stored grass inhibit *Sarcoma*-45.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Phragmites australis (Cav.) Trin. ex Steud. syn. *P. communis* Trin. (*Poaceae*) (COMMON REED; Punjab–*Dila, dambu*).	Coarse reed, up to 3 m, with creeping rhizomes.	From Kashmir to Kumaun, up to 4000 m, in marshy places. Through creeping rhizome.	Long roots help in binding the soil and preventing erosion. When young used as fodder (protein, 11.4%). Useful for pulp, for alcohol, rayon, paper, and pens, thatching, wicker-work, etc. Rhizome, root and young shoot edible.
P. karka Trin. ex Steud. syn. *P. roxburghii* (Kunth) Steud.; *P. maxima* Blatter & McCann in part (Beng–*Nal;* Guj–*Nali;* Hindi–*Narkal;* Kan–*Hulugilu;* Mal–*Nalam;* Mar–*Nala;* Oriya–*Nolo;* Tam–*Perunanal;* Tel–*Naaga-swaramugaddi;* Garhwal–*Bichhra;* Kumaun–*Karka;* Punjab–*Nala*).	Tall reed, up to 6 m, with thick, creeping rhizomes.	Throughout India in marshy places, along banks of lakes and streams, up to 1300 m.	Grown for reclaiming the marshy areas and to prevent erosion. Young grass (protein, 6.6%) eaten by cattle. Other uses are as of *P. australis*.
Phyllanthus fraternus Webster syn. *P. niruri* auct, non Linn. (*Euphorbiaceae*) (Beng–*Bhuiamla;* Guj–*Bhonya anmali;* Hindi–*Jangli amla;* Kan–*Nelanelli;* Mal–*Kizhanelli;* Mar–*Bhuivali;* Oriya–*Bhueola;* Tel–*Neelausirikaaya*).	Herb, up to 60 cm.	Throughout the hotter parts of India. Found on cultivated lands in Deccan desert and ravines in Gujarat.	Suitable for the reclamation of deep and narrow ravines and Deccan desert. Astringent, febrifugal, diuretic, antiasthmatic, antiumour and antiseptic; used in stomach troubles and urinogenital diseases. Leaf employed in LIV-52, useful in jaundice; fresh roots also beneficial. Decoction of leaves dyes cotton black.

Picea sitchensis Carr. (*Pinaceae*) (SITKASPRUCE).		Native to North America, introduced into India.	Recommended for sandstilling in mined areas. Timber useful.
Plantago lanceolota Linn. [Indian plant referred to be var. *mediterranea* (Kerner) Pilger] (*Plantaginaceae*) (Hindi–*Baltanga*).	Perennial herb, up to 1.5m.	Kashmir to Shimla, 1500–2400 m.	Recommended for calcareous metalliferous soils. Young leaves given as a stockfeed and used as vegetable (protein, 8.5%). Leaf and root contain aucubin; former promotes epithelial growth and clotting of blood. Powdered plant mixed with normal diet may cause temporary sterility. Seed (mucilage, 6.5%) used as bird-feed and as an adulterant to BLACK PSYLLIUM (*P. psyllium* Linn).
P. ovata Forsk. (BLOND PSYLLIUM, ISPAGHULA, SPOGEL SEED; Beng–*Eshopgol*; Guj–*Isabgol*, *ghodajeeru*; Hindi & Mar–*Isabgol*; Kan–*Isafagolu*, *visamagolu*; Mal–*Karkatasringi*; Tam–*Iskolvirai*; Tel–*Isapgolavittulu*).	Stemless or sub-stemmed, softly hairy herb.	Cultivated in India in Gujarat, Uttar Pradesh and Punjab.	Grows on a variety of soils, especially sandy or *goradu* in Gujarat. May be useful for reclamation. Seed yields a mucilage, useful in constipation, amoebic and bacillary dysentery and diarrhoea. Yields an oil (5%), useful in lowering serum cholesterol. Mucilage used in cosmetics, as a stabilizer for ice-cream, chocolates, tablets, etc. Husk a good binder.
Platanus orientalis Linn. (*Platanaceae*) (ORIENTAL PLANE; Kashmir & NW Himalaya–*Chinar*).	Large, fast-growing, graceful, deciduous tree, up to 30 m/up to 12 m.	Chiefly cultivated in North-West Himalayas. Grows on moist, deep, well-drained soil near springs or	Useful for the reclamation of the land left after mining. Mostly grown for shade, and on

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
		streams. Frost-hardy. Through seedling, cutting and layering.	the roadside. Timber used for boxes, trays, furniture, and cabinet-making. Bark boiled in vinegar given in diarrhoea and dysentery.
Pluchea lanceolata C.B. Clarke (*Asteraceae*) (Guj, Hindi & Mar–*Rasana;* Delhi–*Rukhri;* Punjab–*Sarmei;* U P–*Baisurai;* Rajasthan–*Chotakalai*).	Erect undershrub, up to 1m.	Punjab, Upper Gangetic plain, Rajasthan and Gujarat. Gregariously occurs in vast areas in dry tracts forming thickets; considered a troublesome weed.	Suitable for sandy and saline soils. Can be fed only to working cattle in mxitures as it possesses high percentage of protein. Bullocks appear well-fed and sleek. Decoction useful in arthritis.
Poa alpina Linn. (*Poaceae*) (ALPINE MEADOWGRASS).	Densely tufted, usually low grass.	Gregarious from Kashmir to Garhwal, up to 4800 m.	Early colonizer on mine-spoils. Useful fodder.
P. compressa Linn. (CANADA BLUEGRASS, FLATTENED MEADOWGRASS).	Stiff, wiry, perennial grass, up to 70 cm.	Found in the temperate parts of Europe, but rarely in India. In America found especially on thin, poor soils and stiff clays. Through rhizome.	Grows on poor soils and stiff clays and forms a close turf and pasture. Used as fodder (protein, 3%); withstands close grazing. Excellent for fattening cattle.
Many species of *Poa* are found in a variety of habitats in high, alpine meadows and form a large part of pasture.			
Polygonum plebeium R. Br. (*Polygonaceae*) (Beng–*Chemtisag;* Guj–*Zinakookhard;* Kan–	Suberect herb or prostrate undershrub, up to 60 cm.	Throughout the hotter parts of India in moist areas, up to 2000 m in Himalayas.	Suitable for reclamation of marshy lands. Eaten by horses. Used as a vegetable. Yields tannin;

Sirangesoppu; Oriya–*Muthisaga;* Delhi–*Macheti;* Lakhimpur–*Banjaluk;* Santal–*Raniphul;* UP–*Machichi*).			powdered herb given in pneumonia.

P. amphibium Linn., *P. barbatum* Linn. syn. *P. stagninum* Buch.-Ham. ex Meissn., *P. glabrum* Willd., *P. hydropiper* Linn. syn. *P. flaccidum* Meissn., *P. limbatum* Meissn., *P. orientale* Linn., and *P. pulchrum* Blume syn. *P. tomentosum* Willd., non Schrank are all found in wet and marshy areas and may be useful for reclamation of such areas. Many are eaten.

Prunus cerasoides D. Don syn. *P. puddum* Roxb. ex Brandis, non Miq. (incl. var. *majestica* Ingram & var. *rubens* Ingram) *(Rosaceae)* (HIMALAYAN WILD CHERRY; Beng–*Padmak;* Guj–*Padmakathi;* Hindi–*Paddam;* Mar–*Padmakastha;* Assam–*Dieng-soh-iong-kerm;* Punjab–*Paja*).	Tree, up to 27 m, with smooth, peeling bark, exposing copper-coloured surface.	From Kashmir to Manipur at 900–2300 m. Produces rootsuckers. Through seed and rootsucker.	Recommended for stabilizing North-eastern hills. Yields good timber, fuel and fodder. Rootsucker makes excellent walking-stick and umbrella-crook. Bark yields tannin and gum. Fruit, though edible, not eaten; may be useful for cherry-brandy.
Pseudoraphis spinescens (R. Br.) Vickery syn. *Andropogon squarrosus* Linn., non Linn. f. *(Poaceae)*.	Floating grass.	Tamil Nadu. Roots in shallow water and floating upon the surface of inland slow-moving rivers, and in lakes and smaller patches of water; sometimes found gregariously on the muddy surface of dried-up pools.	Suitable for saline and alkaline soils.
Pseudotsuga menziesii Franco syn. *P. taxifolia* Britton; *P. douglasii* Carr. *(Pinaceae)* (GREEN DOUGLAS FIR).	Tall, graceful tree, exceeding 100 m/12 m, with 30 cm thick, corky bark,	Introduced at Manali and on the neighbouring hills, at 1800–2000 m; does not thrive at higher altitudes. Young trees frost-tender. Through seed.	Recommended for afforestation on open, eroded lands on the hills. Timber used for houses, bridges, furniture, railway-carriages, boxes, etc. Young twig and leaf used for

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
			making a kind of tea. Inner bark eaten; bark (wax, 3.5–6.0%; tannin, 8.18%) used as a substitute for cork; also possesses insecticidal properties. Exudes an oleresin known as OREGON BALSAM. Wax used in polishes, ointments, lubricants, etc.
Pterocarpus dalbergioides Roxb. syn. *P. indicus* Baker, non Willd. *(Fabaceae)* (ANDAMAN PADAUK, ANDAMAN REDWOOD; Tam–*Vengai;* Tel–*Yerravegisa;* Andamans–*Chalangada;* TRADE–*Andaman Redwood, padauk*).	Very large, semi-deciduous or practically evergreen, buttressed tree, up to 45 m/up to 5.5 m.	Found in the Andamans and sparingly cultivated in West Bengal and South India. Grows best on well-drained, lower slopes of hills and in the valleys, generally along the tidal creeks above the mangrove belt. Usually found on soil derived from sedimentaries consisting of sandstones and conglomerates. A light-demander. Extremely frost-tender. Coppices well. Through seed and transplanting.	Can be grown on waterlogged areas; recommended for agro-forestry. Fixes nitrogen. Timber highly valued for ornamental and decoration works, heavy carpentry, etc. Good firewood.
P. marsupium Roxb. (INDIAN KINOTREE; Beng–*Pitshal;* Hindi–*Bijasal;* Guj–*Biyo;* Kan–*Honne;* Mal–*Venga;* Mar–*Asan;* Oriya–*Byasa;* Tam–*Vengai;* Tel–*Yegi, peddagi;* TRADE–*Bijasal*).	Moderate to large, deciduous tree, up to 30 m/up to 2.5 m.	Hilly regions throughout the Deccan Peninsula extending into Gujarat, Madhya Pradesh, Uttar Pradesh, Bihar, Orissa, up to 1100 m. Often found on red loam soils, with 750–2000 mm,	Can be grown on grassy blanks and on island-region. Timber used for buildings, railway-carriages, wagons, carts and boats, pulp, etc. Used as fuel (sapwood, 4904 kcal; heartwood 5141 kcal/kg). Lopped

		rainfall. Through seed and transplanting.	for fodder. Tree yields a KINO GUM, used in diarrhoea and dysentery.
Pterygota alata R. Br. syn. *Sterculia alata* Roxb. (*Sterculiaceae*) (Beng–*Buddha narikel;* Kan–*Kolugida;* Mal–*Kodathani;* Tam–*Kodaittondi;* Andamans–*Letkok;* Assam–*Tula;* Khasi–*Dieng-soh-lakor;* Lushai–*Phunber-pai;* TRADE–*Narikel*).	Fast-growing, tall, handsome, often buttressed tree, up to 45 m/ up to 3 m.	Found in eastern Himalayas and Assam; on the western ghats form North and Uttara Kannada southwards; cultivated for ornament in avenues and gardens. Found in moist situations in evergreen forests; also in dry localities. Withstands fairly dense shade. Coppices well. Through seed, transplanting and stump-planting.	Can be grown on grassy blanks and island-region; recommended for social forestry. Timber chiefly used for tea-boxes, light packing-material, plywood, light furniture, matchboxes, etc. Yields very good fuelwood (5160 kacl/kg). Bark yields a rough cordage. Roasted seed eaten in Assam.
Pyracantha crenulata Roem. syn. *Crataegus crenulata* Roxb. (*Rosaceae*).	Large shrub to small tree, up to 6 m.	Himalayas from Himachal Pradesh to Bhutan at 720–2400 m.	Suitable for growing in cold deserts and denuded hilltops.. Timber used for axe-handles, staves and walking-sticks.
Quillaja saponaria Molina (*Rosaceae*) (SOAPBARK, QUILLAIA BARK).	Evergreen, graceful tree.	Native to Andes in Chile and Peru, introduced into India and cultivated in Botanic gardens, Udagamandalam, Nilgiris. Drought-resistant. Through transplanting.	Suitable for afforestation of arid and cool areas. Bark used for industrial and medicinal purposes. Yields a soap used as detergent, in cosmetics and medicine.
Randia malabarica Lam. syn. *Benkara malabarica* (Lam.) Tirveng.	Erect or scandent much-branched, thorny shrub or	Orissa and southwards in most areas of the Peninsula; usually in	Very useful for afforestation and fencing. Timber provides fuel.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
(*Rubiaceae*) (Kan–*Bilikaremullu;* Oriya–*Phirika;* Tam–*Pidathi, pudan;* Tel–*Peddalli, peddamalle*).	small tree, up to 2.4 m.	dry, evergreen,scrub forest.	Plant browsed by goats, and withstands grazing.
Ŕ. uliginosa DC. (*Rubiaceae*) (Beng–*Piralo;* Guj–*Gangeda;* Hindi–*Pindalu;* Kan–*Kare;* Mal–*Pannikara;* Mar–*Pendari, telphetru;* Oriya–*Pendra;* Tam–*Wagatta;* Tel–*Nallakakisha;* Assam–*Bon-bongana;* Garhwal–*Mainphal;* Kumaun-*Pnidru*).	Deciduous, armed tree, up to 7.5 m/1.2 m, with quadrangular branches. *Fl. & Fr.:* February–March.	Throughout India, up to 1000 m. Drought- and frost-hardy, Freely produces rootsuckers.	Bark, leaf and fruit contain tannins. Can be grown on waterlogged areas. Timber useful for small articles; may be substituted for boxwood. Leaf lopped for fodder. Leaf boiled and eaten. Root and roasted pulp of fruit given in diarrhoea and dysentery and as a diuretic. Flower yields an essential oil similar to GARDENIA OIL.
Raphia farinifera Hylander syn. *R. pedunculata* Beauv.; *R.ruffia* Mart. (*Arecaceae*) (RAFFIA).	Short-stemmed robust palm, up to 9 m/ up to 3.2 m, with 15-m long leaves.	Native to Malagasy, introduced into India, grown up to 1500 m; preferably grows in low-lying areas and lake-levels in Malagasy.	Recommended for cultivation on wastelands of mined sites, and low-lying areas and lake-levels. Leaf-midrib used for roof- and tent-poles. Leaf yields a wax used in boot- and floor-polishes. Yields a fibre also. Fruit (24%) and seed (1%) yield edible oils. Fruit-shell used for receptacles, snuffboxes, ciggerette-holders and buttons.
Remirea maritima Aubl. (*Cyperaceae*).	Sedge, with rhizomes sometimes growing several	Found growing on the coastal sandy regions, almost within tidal	Effective sand-binder for coastal sands.

	metres long, rooting at nodes and producing erect stems, up to 15 cm.	limits in westcoast in Dakshina and Uttara Kannada and Malabar Dist. Through rhizome.	Rhizome astringent and diuretic. Root aromatic and medicinal.
Rhynchelytrum repens (Willd.) C. E. Hubbard (*Poaceae*) (NATAL-GRASS, RUBY-GRASS).	Short-lived perennial or annual, tufted grass, up to 1 m.	Introduced into Assam.	Used to revegetate abandoned cultivated land, and on saline and alkaline soils. A good fodder; can be converted into hay (dig. protein, 2.42%).
Rhynchosia minima DC. (*Fabaceae*) (Guj–*Nahani kamalvel;* Kan–*Ghattavare;* Mar–*Daktaranghevada;* Tam–*Chittavarai;* Tel–*Gaadidachikkuukaaya, neelaalamu*).	Twining or trailing, annual, herb. *Fl. & Fr.:* June–November.	All over the plains and on the Himalayas, up to 1200 m. Grows in arid zones on sand-dunes of Rajasthan. Through seed.	Recommended to stabilize sand-dunes in arid areas. Fixes nitrogen. Useful as fodder (crude protein, 13.6%).

R. cana DC., *R.capitata* DC. syn. *R. aurea* DC. and *R. rufescens* DC., found almost throughout the plains, some ascending up to 1500 m on the hills, can be used as green manure and fodder.

Rosa multiflora Thunb. (*Rosaceae*).	Vigorous, climbing shrub.	Native to China and Japan, introduced into India, now runs wild in Uttar Pradesh and Assam. Used as a hardy rootstock.	Useful for soil-conservation and erosion-control; recommended for reclamation of cold deserts; grown as a hedge and windbreak. Fruit used as a food; cathartic.
Rosa spp (Wild Roses)	–	–	Recommended for reclamation of cold deserts.
Rothia indica (Linn.) Druce syn. *R. trifoliata* Pers. (*Fabaceae*) (Tam–	Copiously branched, diffuse annual.	Almost throughout the plains of peninsular India, up to 2000 m.	Withstands salinity well; may be tried as green manure for alkaline

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Nurreypitten keerai; Tel–*Noocha-koora*).			and saline areas. Fixes nitrogen. Boiled leaf and pod are eaten.
Rumex acetosella Linn. (*Polygonaceae*) (SHEEP-SORREL; Beng–*Chuka-palam;* Hindi–*Chuk*).	Erect or decumbent perennial, up to 25 cm.	Eastern Himalayas and on the Nilgiri hills, up to 2400 m. Through seed.	An early colonizer on wastes of mines. Naturalized throughout the temperate regions in fields, lawns and waste places. Fruit used as poultry-feed. Young shoot eaten as salad (ascorbic acid 50–150 mg/100 g); laxative.
R. dentatus Linn. (Hindi–*Amrule;* Delhi–*Lalbibi; jangli palak*).	Erect, deep-rooted annual, up to 1 m.	Himalayas, up to 300 m and in the plains from Assam to western and southern India. Through seed.	Suitable for growing in marshy wastelands. Leaf edible; rich in vitamin -A &-C calcium and β-carotene; laxative. Root yields a dye.
R. hastata D. Don (Kumaun–*Amlora;* Punjab–*Khattimal*).	Bushy shrub or undershrub, up to 90 cm, with woody rootstock.	Chiefly on dry rocks and hillsides of western Himalayas from Kashmir to Kumaun, at 300–2400 m.	Suitable to revegetate denuded hilltops and mine wastelands. Leaf acidic and eaten. Bark and root yield tannins (21–23%).
R. maritimus Linn. (GOLDEN DOCK; Beng–*Bun-palung;* Hindi–*Jubpalum;* Punjab–*Khattikan*).	Stout, erect herb, up to 1.2 m.	Temperate Himalayas, Assam, West Bengal, western ghats, Nilgiri and Palni hills on wet areas.	Grows along river-banks, and marshy waste places; may be useful for reclamation.

			Plant eaten as potherb. Leaf and root laxative.
Sacciolepis interrupta (Willd.) Stapf syn. *Panicum interruptum* Willd. (*Poaceae*) (Beng–*Nardula;* Kan–*Modikahullu;* Tam–*Tandanpillu;* Tel–*Wolam;* Bombay–*Pakalia*).	Large perennial, up to 1.8 m.	Assam, West Bengal, Bihar, Orissa, Tamil Nadu and Maharashtra, up to 900 m. Flourishes along streams near ponds, tanks and marshes and swamps. Through seed and rooted stem-cutting.	Suitable for mud-binding in alluvial swamps and preventing erosion. Good fodder. Grain eaten during scarcity.
Salvia aegyptiaca Linn. (*Lamiaceae*) (Punjab–*Tukhammalanga*).	Much-branched, scabrid and hispid, straggling undershrub.	Rocky arid areas in Delhi, Punjab, Rajasthan, Gujarat and Maharashtra.	Suitable for eroded rocky sufaces and piedmont plains.Browsed by sheep and goats. Seed produces mucilage and given as demulcent in diarrhoea and haemorrhoids. Mixed with those of *Plantago ovata*.
Sarothamnus scoparius Wimmer ex Koch syn. *Cytisus scoparius* Linn. (*Fabaceae*) (BROOM, SCOTCH- OR YELLOW-BROOM).	Small, deciduous shrub, up to 3 m.	Introduced into India, commonly found around Shimla, and the Nilgiris; found as an escape, at 2100–2400 m.	A sand-binder, recommended for the reclamation of coastal areas; less affected by salts; can grow on calcium- and phosphate-deficient soils. Fixes nitrogen. Green twig used either fresh or after drying as a heart-tonic and diuretic in dropsy.
Schinus molle Linn. (*Anacardiaceae*)	Short-boled tree, up to	Introduced into India form South	Very tolerant of various soils, but

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SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
(Peruvian Peppertree, Mastic Tree; Kan–*Hucchumenasina-mara*).	8 m, with graceful pendulous branches.	America, planted in gardens, parks, lawns, avenues and cemeteries. Drought-resistant. Through seed, cutting and layering.	not waterlogged; best adapted to higher elevations. Suitable for arid and semi-arid areas. Fruit sweet at first finally acquiring a sharp,peppery taste; not eaten but employed as condiment and adulterated for those of *Piper nigrum*. Yields an essential oil (3.35–5.20%) and a resin resembling ginger-resin. Tree exudes a gum-resin; considered purgative, expectorant and diuretic. Bark yields tannins(23%).
Schleichera oleosa (Lour.) Oken. syn. *S.trijuga* Willd. & Klein (*Sapindaceae*) (The Lac-tree, Ceylon-oak; Beng, Guj, Hindi & Mar–*Kusum*; Kan–*Chakota*, *sagade-kendala*; Mal–*Puvam*; Oriya–*Kusamo*; Tam–*Puvathipavam*; Tel–*Posuku*, *kodalipulusu*; Punjab–*Jamoa*, *kussum*).	Evergreen tree, 33 m/ up to 3.7 m.	Sub-Himalayan tract from Kashmir to West Bengal and in Central and peninsular India, up to 900 m, found growing in the outer hills, ravines or on edges of terraces, near stream-banks; prefers slightly acidic soil. Cultivated for lac, oil and as ornament. A shade-bearer. Drought- and frost-hardy; coppice-power varies. Pollards well but heavy pruning slows the growth. Through seed and rootsucker.	Recommended for moist localities on the sides of ravines, river-banks, boulder-beds, lower hill-terraces. Timber useful for cabinet-work. Makes excellent fuel (sapwood, 4950 kcal; heartwood, 4928 kcal/kg) and charcoal. Leaf used as fodder (crude protein, 10.37%). Cake used as fuel. Ripe fruit and seed edible. Oil from seeds (35–45%) (Macassar or Kusum Oil) used for hair-

			dressing, culinary and lighting; used in rheumatism. Cake useful as manure. Host for lac-insect.
Scirpus grossus Linn. f. syn. *S. kysoor* Roxb. (*Cyperaceae*) (Beng & Hindi–*Kasuru;* Guj–*Gundaro;* Mar–*Kasara;* Oriya–*Santara;* Tel–*Gundutungagaddi;* Mundari–*Jomekesari, marangkhesari;* Punjab–*Dila, kaseru*).	Large, glabrous perennial, up to 2.7 m, with stout, sometimes stoloniferous rootstocks, producing dark-coloured, globose tubers during dry season.	Throughout India, up to 700 m. Through stolon.	Recommended for conversion of shallow-water areas into arable land and also in afforestation of marshy wastelands; good soil-binder. Used as green manure in paddy-fallows. Green parts and rhizome used as fodder. Dry plant employed as roof-cover. Rhizome (protein, 7.5–11.8%) nutritious and eaten; used for stopping vomiting and diarrhoea.
S. roylei Parker syn. *S. quinquefarius* Buch.-Ham. ex Boeck. (Rajasthan–*Morlo*).	Erect, tufted, fibrous-rooted, annual, up to 25 cm.	Jammu, Punjab and Rajasthan to Assam, extending up to Maharashtra. Common all over the paddy-growing areas in wet and muddy areas.	Suitable for reclamation of marshes near canals, streams and ponds.
S. tuberosus Desf. syn. *S. maritimus* C. B. Clarke, non Linn. (SEACLUBRUSH; Beng–*Mahatkesur;* Tel–*Gurrapusaalatunga;* Punjab–*Dila, murak*).	Robust, amphibious sedge, up to 90 cm, with woody rhizome.	Throughout India, commonly in marshy areas and on the banks of streams, up to 3000 m.	Suitable for afforestation of saline soil. Green plant forms good forage. Rhizome (crude protein, 10.3%) eaten; laxative.

Many *Scirpus* spp, such as *S. articulatus* Linn.: C.B.Clarke (Fl Br Ind) in part (Beng–*Laghukeruru;* Hindi–*Chichora;* Oriya–*Gaichara*); *S. inclinatus* Boiss.syn. *S. corymbosus* Roth.; *S. juncoides* Roxb. syn.*S. erectus* C. B. Clarke (Fl Br Ind), non Poir.; *S. lacustris* Linn.(GREAT

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
BULRUSH, CLUBRUSH); and *S. littoralis* Schrad., are soil-binders and aid in natural conversion of shallow-water land to arable lands. Some form good forage. Rhizomes edible. Seeds of some species are powdered and eaten. Many species form basic raw materials for mats, thatching and wicker-work. These are used as green manures.			
Sehima ischaemoides Forsk. (*Poaceae*).	Tall, erect perennial, up to 25 cm. *Fl. & Fr.*: August–December.	Maharashtra and southern India.	Suitable to grow on sand, rocky soil and hilltops. Good fodder in subdesert areas where it springs up in rainy season.
Sesuvium portulacastrum Linn. (*Aizoaceae*) (SEASIDE PURSLANE; Beng–*Jadupalang;* Tam–*Vungaravasi;* Tel–*Vangarreddikoora;* Bombay–*Dhapa*).	Small prostrate, succulent herb, with stems and leaves often deep red.	Common weed on sea-coasts throughout India.	Useful sand-binder; can be grown on estuarine areas also. Sometimes cultivated as vegetable.
Sonneratia apetala Buch-Ham. (*Sonneratiaceae*) (Beng & Oriya–*Keora;* Mar–*Undi;* Tam–*Marama;* Tel–*Kyalanki*).	Small to medium-sized tree, clear bole up to 8 m/2 m.	Found in tidal forests of coastal regions of West Bengal and greater part of peninsular India in the saline soils in mangrove-forests. Rapidly grows in Sundarbans. Vigorously coppices.	Suitable for afforestation of estuarine coastlands. Early colonizer on newly formed alluvial soils. Timber used for houses, packing-cases, chests, and for rough construction, planks,etc. Yields good fuelwood (sapwood, 4901 kcal/kg). Stem-bark (11.0–16.6%), twig-bark (14%), leaf (8%) and fruit (9.6–10.0%) yield tannins, used for producing leather. Unripe, sour fruits eaten.

S. caseolaris Engl. syn. *S.acida* Linn. f. (Beng–*Orcha;* Kan–*Kandale;* Mal–*Thirala;* Mar–*Tiwar;* Oriya–*Sundarignua;* Tam–*Kinnari*).	Medium-sized tree, up to 20 m/1.5 m. with pneumatophores of 60 cm/ up to 50 cm.	Almost along the entire coast and the Andaman Islands; occurs in creeks and mangrove-swamps.	Suitable for reclamation of estuarine coastlands. Timber for cabinet-work, pulp, interior construction, piles, bridges, boat-making and musical instruments. Stembark (9–17%) and twigbark (11.0–11.9%) yield tannins. Fruit edible; useful as vermifuge.
Sorbus aucuparia Linn. syn. *Pyrus aucuparia* Gaertn. (*Rosaceae*) (ROWAN TREE, MOUNTAIN-ASH; Punjab-*Baltal*).	Small to moderate-sized tree.	From Kashmir to Kumaun, at 3500–4000 m.	Recommended for conservation of soil and control of erosion; also cultivated as an ornament. Infusion of leaf laxative. Bark used in tanning. Fruit used in the preparation of extracts, syrups, jams and juices; a good source of vitamin-C; powdered fruit made into a bread; infusion given in haemorrhoids and strangury. Seed contains a fixed oil (22%) and tannins (4.5%).
Soymida febrifuga A. Juss. (*Meliaceae*) (INDIAN REDWOOD; Beng, Hindi, & Mar–*Rohan;* Guj–*Rohina;* Kan–*Suani;* Oriya–*Sohan;* Tam–*Shem;* Tel–*Sumi; sonidamaanu;* Santal–*Ruhen*).	Lofty, deciduous tree, up to 25 m/ up to 3 m.	From Gujarat, Uttar Pradesh and Bihar extending into peninsular India up to Kerala. Through seed and transplanting.	Suitable for reclamation of stony hills and laterite soils. Timber used for posts, rafters, beams, agricultural and household implements and for quality furniture. Bark yields tannins (17.4%), dye,

Species/Family/Names	Characters	Distribution/Propagation	Utilization
			resin, gum and fibre; used in diarrhoea, dysentery and fevers; sometimes employed in dyeing cotton-cloth. Decoction used for gargles and washing. Resin, astringent and antiperiodic.
Spartium junceum Linn. (*Fabaceae*) (SPANISH OR WEAVER'S BROOM).	Handsome, aromatic shrub, up to 3 m, with long slender, rush-like branches.	Grown in Himachal Pradesh and Punjab; grows on almost any kind of well-drained soil, and easily naturalized. Through seed and green wood-cutting.	Suitable for bauxite-mined wastelands. Can also be grown on any well-drained soil. Fixes nitrogen. Yields a fibre used for paper-making, mats, mattresses, pillows and partly for rubberized belts. Flower a source of precious perfume (concrete 0.09–0.18%).
Spergula arvensis Linn. (*Caryophyllaceae*) (CORNSPURRY; Delhi–*Muchmuchia*).	Sticky, glandular annual, up to 60 cm.	Found as a weed in cultivated fields all over India, particularly cooler parts.	Recommended as a soil-renovator for sandy soils and also as a green manure. Potential source of organic matter and increases the availability of N, P, K in the soil. Yields fodder (crude protein, 19.5%). Seed yields an oil (10%), used in pulmonary tuberculosis.

Stenotaphrum dimidiatum Brongn. syn. *S. glabrum* Trin. (*Poaceae*).	Coarse, prostrate, perennial.	Common in India under mango-trees and near the seashore.	Suitable for coastal saline soils. Left to itself it forms a coarse turf. A good pasture.
Stereospermum suaveolens DC. (*Bignoniaceae*) (Beng–*Parlu;* Hindi & Mar–*Paral;* Kan–*Hudaybilla;* Oriya–*Patoli;* Tam–*Padri;* Tel–*Goddalipulusu;* Kashmir–*Phallai;* Lepcha–*Singyen;* Punjab–*Padal;* Santal–*Pader*).	Deciduous tree, up to 18 m/ 1.8 m.	Throughout the greater part of India in mixed deciduous forests, up to 1500 m. A moderate light-demander. Recovers from injury and damage from fire and frost. Through seed and transplanting.	Can be grown on dry, upper slopes and ridges on sand- stone and useful for afforestation of exposed dry hillsides and grassy blanks. Useful in block-planting. Recommended for social forestry. Timber used for constructional works; yields excellent firewood and charcoal. Leaf lopped for fodder. Bark shows hypoglycaemic and anticancer activity. Rootbark given in fevers and inflammation in chest.
Stipa jacquemontii Jaub. & Spach (*Poaceae*).	Tufted, shortly rhizomatous perennial, up to 90 cm. *Fl. & Fr.:* July–September.	North-West Himalayas; grows on arid soils and often in the crevices of cliff-faces. Hardy.	Useful colonizer in arid, temperate regions and may be useful for reclamation.
Swietenia macrophylla King (*Meliaceae*) (PERUVIAN MAHAGONY TREE; Beng–*Bara-mahagoni;* Mal & TRADE–*Mahagony*).	Beautiful, lofty, evergreen tree, with straight, cylindrical trunk, up to 40 m/ 4 m. *Fl. & Fr.:* April–May; February–March.	Native to tropical Mexico, and South America, introduced into South India, planted in West Bengal, Bihar, Orissa, Karnataka, Tamil Nadu, Kerala, Maharashtra, and Dehra Dun. Grows on variety of soils. Through seed, transplanting and stump-planting.	Suitable for afforestation of eroded soils. Useful on wetlands, waterlogged areas and grassy blanks and for reclamation of tin-spoils. Timber used for furniture and plywood. Seed yields an oil (50%), useful for soap-making.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
S. mahagoni Jacq. (JAMAICAN MAHAGONY TREE; Beng–*Mahagni;* Mal–*Cheriamahagami;* Tam–*Ciminukku, mahagony;* Tel–*Mahaagonichettu;* TRADE–*Mahagony*).	Magnificent, buttressed, evergreen tree, up to 30 m/4.5 m. *Fl. & Fr.:* February–May; October–January.	Native to Central America, cultivated in many parts of India.	Recommended for social forestry. Timber excellent and praized decorative furniture, woodwork, musical instruments, mathematical instruments, ship-building, etc. Bark yields gum, tannins (15%).
Syncarpia glomulifera Sm. ex Niedenzu syn. *S. laurifolia* Tenore (*Myrtaceae*) (TURPENTINE-TREE)	Large, quick-growing, evergreen tree, up to 45 m/ 1.2 m.	Occasionally planted in South India.	Difficult to burn and hence used as fire-breaks and windbelts; planted for shade, shelter and ornament. Can withstand lopping and trimming; hence good for hedges. Timber used for sleepers, ship-building and cabinet-work. Bark yields a kind of turpentine.
Taxodium distichum Rich. (*Taxodiaceae*) (BALD CYPRESS).	Deciduous tree, up to 45 m /5.7 m, with a concial crown when young but flattened one when old.	Native to the USA and Mexico, successfully introduced into FRI, Dehra Dun, and Himachal Pradesh. Thrives on moist and loamy soils. Produces CYPRESS-KNEE in wet and swampy places. Young plants need protection from the sun and frost. Through fresh seed, cutting and stumps–stumps a rare feature in conifers.	May be used for afforestation and landscaping of heavily waterlogged areas; recommended for social forestry. Timber used for construction of green houses, vats, cooperage, watertanks, etc. Exudes a resin. Bark and seed yield a tannin. Seed possesses anticancer activity.

Tecoma stans H. B. & K. syn. *Bignonia stans* Linn. (*Bignoniaceae*) (Kan–*Koreneklar;* Tam–*Sona-patti;* Tel–*Pachagotla*).	Erect shrub or small tree.	Planted in gardens in the plains throughout India and on the hills,up to 1500 m; also found in dry, waste places.	Can be grown in waste and dry places;may be used as windbreak and shelter-belt under social-forestry programmes.
Tetrapogon tenellus (Roxb.) Chiov. syn.*Chloris tenella* Koenig ex Roxb. (*Poaceae*).	Very slender annual, up to 40cm.	North-West and South India.	May be grown for preventing erosion. Very useful fodder for arid regions.
Themeda anathera (Nees ex. Steud.) Hack. syn. *Anthistiria anathera* Nees ex Steud. *(Poaceae)* (Dehra Dun–*Ghatira*).	Gregarious, tufted, perennial, up to 1.2 m.	From Kashmir to Kumaun, at 1300–3000 m; abundant on dry soils and sheltered and shady slopes.	Recommended for reclamation in Gujarat and Deccan. Tolerates grazing. Mature plant used as hay (protein, 3.18–6.70%).
T. triandra Forsk. syn. *A. imberbis* Retz.(ROOIGRASS, RED GRASS; Guj–*Bhatdi;* Kan–*Bettanchihullu;* Tam–*Erigaithattupullu;* Tel–*Peddayerrakallakasura*).	Stout, perennial, up to 2.1 m.	Assam to Kerala, up to 1200 m in the Himalayas. One of the most common grasses of the drier regions of Africa.	Gregariously grows in stony and inhospitable places and can be grown in for reclamation. Presence of plant indicates suitability of land for pineapple cultivation. Valuable and nutritious fodder (protein, 2.52%) before flowering; relished by cattle; also used as hay. Locally used for thatching. Grain used as food.
Thevetia peruviana (Pers.) Merrill syn. *T. neriifolia* Juss. ex Steud. (*Apocynaceae*) YELLOW OLEANDER; Beng–*Koklaphul, haldi korubi;* Guj & Hindi–*Pilakaner;* Kan–*Kadukasi;* Mal–*Manjaareli, pachchaareli;* Mar–	Large, evergreen shrub, up to 6 m.	Native to tropical America and the West Indies, naturalized in plains throughout India and grown on several soils. Requires little attention except sunshine and well-drained soil with open compost.	Since drought- and frost-resistant and not browsed by livestock useful for afforestation of moist tracts and dry,rocky soils, etc. Also can be planted along canal-bunds. Yields compost. Recommended for

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Pilvalakanhera; Oriya–*Konyarphul;* Tam–*Pachaiyalari;* Tel–*Pachaganneru*).		Fairly drought- and frost-resistant. Through seed, transplanting and cutting.	shelterbelts, windbreak and social forestry. All parts produce highly poisonous latex.
Thuarea involuta R. Br. ex Roem. & Schult. syn. *T. sarmentosa* Pers. (*Poaceae*).	Littoral, low-growing, prostrate grass.	Occurs just above the high-tide level in the Nicobar and Lakshadweep Islands, creeping for considerable distances in all directions over the sand.	Good soil-binder; can be grown on coastal saline soils. A good fodder.
Thuja occidentalis Linn. (*Cupressaceae*) (AMERICAN ARBORVITAE, WHITE CEDAR).	Evergreen tree, up to 20m/up to 5.4 m.	Introduced into India from North America, grown as a CHRISTMAS TREE in the plains.	Attractive landscape tree, much cultivated for hedges and windbreaks; grown for reforestation in some countries. Tolerates sulphur dioxide and hydrogen flouride fumes. Yields OIL-OF-THUJA.
T. plicata D. Don syn. *T. gigantea* Nutt. (GIANT ARBORVITAE, WESTERN RED CEDAR).	Fast-growing, pyramidal tree, up to 60 m/6 m.	Native to North-West America, introduced into Himachal Pradesh and West Bengal; grown for ornament. Succeeds on clayey soils and withstands cold and shade.	Useful for sand-stilling in mined areas. Grown for hedge and shelters and forms good screen; withstands pruning. Tolerates sulphur dioxide and hydrogen flouride fumes.
Tilia cordata Mill. (*Tiliaceae*) (SMALL-LEAVED LIME- OR LINDEN).	Large tree, up to 30 m.	Native to Europe, introduced into some parts of Himachal Pradesh, at *c* 2100 m.	Suitable for establishing plantations on open, eroded land; grown on roadsides; helps in the removal

			of lead compounds from the air. Timber used for carving and inlay-work and for making artificial limbs and musical instruments. Yields charcoal, suitable for art-work. Flower stomachic.
Tragus roxburghii Panigr. syn. *T. biflorus* Schult., non auct.; *T. racemosus* Hook. f. (Fl Br Ind), non All. nec. Pres. (*Poaceae*) (Guj–*Vandariughas;* Kan–*Antupuralehullu;* Tel–*Mullagaddi;* Rajasthan–*Charchcada, sitaghas*).	Tufted, prostrate, ascending, or erect grass, up to 15cm.	Throughout India in the dry plains, up to 900 m. Hooked glumes stick to the animals and clothes of human beings resulting in dispersal of seed.	Useful sand-binder; recommended for rangelands. Much grazed during the rains and said to be nutritious.
Trewia nudiflora Linn. (*Euphorbiaceae*) (FALSE WHITE TEAK; Beng–*Pitali;* Hindi–*Gamhar pindara;* Kan–*Katkumbala;* Mal–*Kattukumil;* Mar–*Petari;* Oriya–*Monda;* Tam–*Attupuvarasu;* Tel–*Eeruponaku;* Assam–*Bhelkol;* Cachar–*Panipitho;* Garo–*Boldiktat;* Khasi–*Dieng-soh-lyndot;* Lepcha–*Thungplam;* Mundari & Santal–*Gadalopong;* TRADE–*Gutel*).	Fast-growing tree, 25 m. Male tree handsome and female with comparatively shorter stems and wide-spreading branches.	Almost throughout India from Yamuna eastwards and southwards up to 1200 m, particularly along the streams and in moist and swampy places; also cultivated for ornament. A moderate light-demander. Sensitive to drought but fairly frost-hardy. Vigorously coppices. Through seed and rootsucker.	Recommended for waterlogged areas. Suitable for agro-forestry in *terai* and *babhar* tracts.
Trianthema triquetra Willd. ex Rottl. syn. *T. crystallina* auct., non Vahl	Small, branched, prostrate herb.	Widely distributed in India; sometimes becomes an aggressive	Good sand-binder; forms green carpet on sandy and dry soils. Can

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
(*Aizoaceae*) (Kan–*Naisoppu;* Tam–*Sirusharanai;* Tel–*Kukkapaalakoora;* Punjab–*Alethi;* Rajasthan–*Patharphor*).		weed.	be grown to control erosion.
Tribulus terrestris Linn. (*Zygophyllaceae*) (LAND CALTROPS, PUNCTURE-VINE; Beng, Hindi & Oriya–*Gokhura;* Guj–*Betagokhra;* Kan–*Sannaneggilu;* Mal & Tam–*Nerunji;* Mar–*Lahangokhru;* Tel–*Chinnapalleru;* Ladakh–*Rasha;* Punjab–*Lotak;* Rajasthan–*Gokhatri*).	Variable, prostrate, annual, up to 90 cm. *Fl. & Fr.:* Throughout the year.	Common throughout India, up to 5400 m; grows in arid regions of Rajasthan desert, on hills, rock outcrops and alluvial soils. Springs up even after rains.	Can be grown for stabilizing the arid, sanay regions and hills. Used as fodder; green parts (crude protein, 12.06%) highly palatable to stock. Leaf (protein, 7.22%) and tender shoot are eaten; rich in calcium. Powdered fruit, made into a bread and eaten; fruit diuretic and tonic and used for the treatment of calculous affections and painful micturition. Root is a constituent of *Dasmoolarishta* and *Amritaprasagritha.*
Tricholaena teneriffae Link (*Poaceae*).	Perennial grass, with many stems arising from a woody rootstock..	Punjab.	Suitable for hot, arid areas and may be useful for stabilizing soil. Can serve as a fodder.
Trifolium alexandrium Linn. (*Fabaceae*) (BERSEEM, EGYPTIAN CLOVER).	Pubescent annual, up to 60cm.	Introduced into India for fodder, found in Punjab, Himachal Pradesh, Uttar Pradesh, Madhya	Useful for reclaiming alkaline and saline soils and in semi-desert areas; used as cover in orchards.

		Pradesh, Bihar, Tamil Nadu, Karnataka and Maharashtra on alkaline soils, heavy loams and on light soils. Cannot withstand frost. Through seed.	Fixes nitrogen; often used as green manure. Grown as pasture and forage-crop (crude protein, 10.23–23.10%) in India; can be given as green fodder, silage and hay; contains high amount of calcium.
			A good source of honey.
T. pratense Linn. (PURPLE, RED or BROAD-LEAVED CLOVER; Punjab–*Trepatra, chitabatto*).	Small, hairy perennial.	Kashmir to Garhwal, at 1200–2400 m; also wild on the Nilgiris. Through seed.	Recommended for reclaiming cold deserts. Fixes nitrogen. A useful green feed (crude protein, 13.50%) and hay (crude protein, 18.30%). Withstands grazing better thar. other legumes.
T. repense Linn. (WHITE or DUTCH CLOVER, SHAMROCK).	Creeping perennial.	Probably native to northen USA and Canada, found on the temperate and alpine Himalayas, at 2000–4800 m; introduced into the Nilgiris. Through seed.	Can be grown as a soil-cover; useful to grow on flyash. Fixes nitrogen and improves the soil. Forms an excellent pasture (crude protein, 25.27–25.57%) and withstands grazing. Used as hay (crude protein, 13.5%), silage.
Triphasia trifolia (Burm.f.) P. Wils. (*Rutaceae*) (LIMEBERRY, MYRTLE-LIME, CHINESE LIME; Beng & Hindi–*Cheeninaranghi;* Kan–*Kaadusirinimbu;* Mar–*Chinke-limbu*).	Thorny shrub or small tree,up to 7 m. *Fl. & Fr.:* December–February.	Commonly planted in gardens for ornamental fruits. Found wild in some parts of peninsular India and also recorded from Car-Nicobar Islands. Not frost-hardy. Through seed and cutting.	Grows on highly saline soils and recommended for reclamation; may be useful as stock for *Citrus*. Timber useful for small articles; yields satisfactory charcoal.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
			Leaf used in diseases of skin and for bath-salts. Fruit sweet and aromatic and edible; converted into pickles, jams, jellies, syrup, cordial, etc.
Tripogon bromoides Roth ex Roem. & Schult. (*Poaceae*).	Variable, tufted, perennial, up to 45 cm.	Found in South India, at 300–2250 m; also reported to occur in Madhya Pradesh and Assam.	Potential soil-binder. Useful as fodder.
Trisetum flavescens (Linn.) Beauv. syn. *Avena flavescens* Linn., non Hook.f. (GOLDEN OR YELLOW OATGRASS).	Slender, tall, tufted, perennial, up to 90 cm.	Distributed in Sikkim Himalayas, up to 3900 m; grows on a wide range of soils. Fairly drought-resistant.	Makes a fine turf on a wide range of soils at high altitudes and may be grown for erosion-control. Good forage and sometimes cultivated for fodder; highly palatable and nutritious to sheep and cattle; also used for hay.
Tussilago farfara Linn. (*Asteraceae*) (COMMON COLTSFOOT, COUGHWORT; Hindi & Punjab–*Watpan*; TRADE–*Fanjuim*).	White, woolly scapigerous, herb.	From Kashmir to Nepal, at 1500–3500 m.	Sometimes grown for soil-conservation. Young leaf used in soaps and as potherb. Yields mucilage.
Typha australis Schum. & Thonn. syn. *T. angustata* Bory & Chaub.; *T. elephantina* Grah., non Roxb. (*Typhaceae*) LESSER INDIAN	Tall, robust, perennial, up to 4 m, with creeping rhizome.	Throughout India, up to 1730 m.	Suitable for estuarine areas. Young shoot, rhizome, marrow of immature inflorescence eaten in

REEDMACE; Beng–*Kaw;* Hindi–*Patera;* Guj–*Ghabajario;* Kan–*Aanechondu;* Mar–*Pankanis;* Tam–*Sambu;* Tel–*Jammugaddi, dubbujammu*).			various ways; pollen made into sweets. Leaf pliated into several articles.
T. elephantina Roxb., non Grah. nec Schimp. ex Rohrb. syn. *T.angustifolia* Watt, non Linn. (EELEPHANT-GRASS, INDIAN REEDMACE; Beng & Oriya–*Hogla;* Hindi–*Mothitrina;* Guj–*Ghabajarin;* Kan–*Jambuhullu;* Tam–*Anaikkorai;* Tel–*Eenugajammu;* Kashmir–*Pitz, yira;* Punjab–*Boj, bori*).	Gregarious, marshy plant, up to 3.5 m,with stoloniferous rhizome.	From Kashmir and Uttar Pradesh to Assam in stagnant, fresh and brackish water; also cultivated for ornament.	Planted for conserving soil in marshy areas. Favourite fodder for elephants. Young shoots edible. Starchy rhizome and the pollen also eaten. Fibrous leaf and stem used for thatching, screen, wicker-work, etc. Pulp may be converted into rayon.
Ulmus wallichiana Planch. (*Ulmaceae*) (Hindi–*Mored pabuna;* Kashmir–*Brari;* Kumaun–*Maral;* Punjab–*Kain*).	Tall tree, up to 33 m/ 2.7m, with exfoliating bark.	From Kashmir to Uttar Pradesh, at 900–3000 m. A light-demander. Through seed.	Recommended on newly exposed grounds, such as cuttings and embankments, landslips, sides of ravines and abandoned fields of cultivation for reclamation. Timber for light construction, planking, packing-cases, furniture, bobbins, reels, etc. Leaf lopped for fodder. Bark yields fibre used for cordage and for making strings and sandals.

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Urochloa mosambicensis (Hack.) Dandy (*Poaceae*).	Perennial grass variable in size and habit, with stolons or a creeping rhizome.	Introduced into India, grows in denuded areas. Fairly drought-resistant and partially frost-hardy. Through seed and cutting.	Since it freely roots and produces thick vegetative cover, well-suited for soil-conservation in denuded areas. Excellent fodder (crude protein, 11%).
Vicia villosa Roth (*Fabaceae*) (HAIRY VETCH).	Hairy annual or perennial herb.	Introduced and cultivated on the Nilgiri hills. Adapted to cool temperate climates. Prefers sandy or sandy-loam soil. Drought- and cold-resistant. Through seed; propagates very fast and establishes itself very well, forming a thick cover over the soil.	May be grown for soil-conservation as growth is fast and forms thick matting cover. Important green manure, and cover-crop. Fixes nitrogen. Grown for stock-feed and for pasture (crude protein, 12.3%), hay (crude protein, 19.3%), silage, and for vegetable. Seed less toxic compared to *V. sativa*.
Vigna hosei (Craib) Backer syn. *Dolichos hosei* Craib; *V. oligosperma* Backer (*Fabaceae*) (SARAWAK BEAN).	Twining or creeping plant, with shallow root-system.	Native to Borneo, introduced into India as a covercrop for tea and coffee. Thrives in low situations but can also adapt ot extreme dry conditions. Successfully grown in Tamil Nadu. Through seed and cutting.	Useful for checking soil-erosion, as it forms dense cover. A useful green manure. Fixes nitrogen.
Wendlandia exserta DC. (*Rubiaceae*)	Quick-growing, deciduous	Dry forests of the sub-Himalayan	Can be used for afforesting bare

(Beng–*Tilki;* Hindi–*Chaulaichila;* Kan–*Tilai;* Mar–*Padgira;* Assam–*Kadam;* Punjab–*Pausara;* Santal–*Hundra*).	or evergreen, ornamental tree. *Fl. & Fr.*: March–May; April–June.	tract from Chenab eastwards to Sikkim and Assam, up to *c* 1200 cm; also found in hilly places of West Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra. A strong light-demander. Difficult to grow from seed.	hill-slopes and clearings; recommended for agro-forestry. Timber used for buildings, house-posts and agricultural implements. Leaf used as fodder. Bark used in medicine.
Wightia speciosissima Merrill syn. *W. gigantea* Wall. (*Scrophulariaceae*) (Khasi–*Kasland;* Lepcha–*Bopkung:* Lushai–*Chongtlai*).	Large stout, woody climber or a small tree, with a girth up to 1.2 m.	From Nepal to Bhutan, at altitudes of 900–2100 m, extending into hill-forests and ravines of West Bengal.	Suitable for afforestation of bare lands and grasslands. Timber used for idols.
Woodfordia fruticosa Kurz syn. *W. floribunda* Salisb. (*Lythraceae*) (FIRE-FLAME BUSH; Beng & Hindi–*Dawi;* Guj–*Dhavdi;* Mar–*Dhaiphal;* Kan–*Tamrapushpi;* Oriya–*Jatiko;* Tel–*Serinj, jargi;* Bihar–*Icha;* Jammu & Kashmir, Punjab–*Thawi*).	Much-branched, beautiful shrub, rarely up to 7 m. *Fl. & Fr:* January–April; March–June.	Common throughout North India, ascending up to 1500 m in the Himalayas, but scarce in South India. Frost-hardy. Coppices well.	Can be planted for afforestation of landslips and denuded hilltops. Useful soil-improver and efficient nurse to many other species. Used for fuel. Leaf (12–20%), bark (20–27%) and flower (24.1%) yield tannins; flower also yields dye. Flower eaten and yields nectar; a cooling drink is made; antipyretic and promotes granulation. Stem yields a gum.
Wrightia tinctoria R. Br. (*Apocynaceae*) (PALA INDIGOPLANT; Beng, Guj, Hindi & Mar–*Indrajan;* Kan–	Deciduous tree, up to 7.5 m/60 cm.	Rajasthan, Madhya Pradesh and peninsular India, up to 1200 m. A moderate light-demander. Produces	Recommended for social forestry. Used as green manure for paddy. Timber, HALEWOOD, used for

SOME MORE ECONOMICALLY IMPORTANT SPECIES SUITABLE FOR RECLAMATION OF WASTELANDS

Species/Family/Names	Characters	Distribution/Propagation	Utilization
Kodesige; Mal–*Kotakappalla;* Oriya–*Pita karkan;* Tel–*Tedlapaala*).		rootsuckers. Through seed, cutting and rootsucker.	furniture, boxes, various articles, pencils, toys, combs, instruments, blocks, lacquerware. Leaf given as fodder. Leaf and root show hypotensive activity. Leaf yields an indigo. Flower used as vegetable. Tender leaf, pod and seed eaten.
Zoysia matrella (Linn.) Merrill syn. *Z.pungens* Willd.;*Osterdamia matrella* Kuntze (*Poaceae*) (MANILA GRASS).	Creeping grass, up to 90 cm, with rigid rootstock.	Occurs on sandy seacoasts of eastern and western India.	Useful in reclamation of sand-dunes and coastal saline soils. Recommended for turfs in place of *Cynodon dactylon*. Forms a good deep-green, mat-like turf and can grow in humid places. Relished by cattle.

Part III

DEVELOPMENT OF MINED WASTELANDS

Mining is next to agriculture in world's economy. But, mining and its allied works have ravaged and wasted the land-surface more with mine-heads, dumps, tailings, etc. Even the seabeds are not spared. With improving technologies and rapid industrialization, large quantities of ore are being extracted, and the toxic rejects are occupying sizeable areas, causing further disturbances. Only recently, the gravity of the situation has been realized and efforts have been started for the reclamation of such ravaged lands.

The disturbances include stripping or opencast-mining, dumps, tailings and slimes, compaction, heavy-metal toxicity and acidity. Besides these, the toxic wastes from the ore-dependent industries are dumped everywhere including watercourses and these areas also need reclamation. Such disturbances alter the conditions for the vegetative growth and the original community cannot be recreated. Also, devastation due to pollution downstream and its effects on the ecological system, human life and groundwater aquifers, etc. need much attention. The overall resultant environment is not suitable for any agriculture, pasturing, forestry, and pisciculture. The high rate of sediment is detrimental to aquatic life. Due to lack of proper regulations, millions of hectares of unreclaimed mined land are left unattended. The area currently reported to be disturbed from mining the world over is *c* 386,000 ha/year. In India, an area of 683,672 ha spread over 19 states has been leased out for mining, the maximum being in Rajasthan, Bihar and Orissa; this may increase considerably by 2000 AD. Work to reclaim such lands has very recently been started by some organizations. The government also is now insisting upon the reclamation of the devastated surfaces before new leases are sanctioned.

Several countries have enacted legislations to control the effects of mining and stipulated that the removal and storage of topsoil for reuse, refilling of mined areas with landscape and natural hydrology, and planting suitable ground-cover to reclaim these lands are necessary.

Work on finding the suitable indigenous plants in India is virtually non existent compared to the problem. Hardly any work was done on the reclamation of mine-spoils and hardly any plant suitable for reclamation of various mine-spoils was identified. Only recently work on iron-ore, bauxite, lignite and limestone spoils has been started in India. In this account, plants identified for reclamation of various types of mines elsewhere and also recorded from India have been discussed, though climatewise some of these species may not be suited to various mine-spoils.

Reclamation of these mined lands is very intricate, complicated and site- or mine-specific. Premining trials of the earmarked areas for reclamation should be undertaken by estimating the overburdens and tailings. Also, the species existing there should be recorded and stocked. Establishing the vegetation on these sites is generally difficult because of altered *p*H, variable texture, lack of organic matter, fragmented rocks and many other adverse biological and toxic-chemical factors. Integrated biological and mechanical practices can make successful reclamation possible. Methods for developing these areas with the species which had existed before mining or species which are tolerant to such sites should be considered.

Each type of waste determines the type of vegetation and the degree of establishment of such vegetation. For suitable, successful vegetative cover, the soil or overburden may require alteration of both physical and chemical properties. Chemical treatment may, however, be limited to irrigation, penetration or establishment in phases. Proper vegetative cover from natural vegetation is also essential. Species which can be planted as intermediates may function as a nurse-crop and also improve the soil.

Fertile topsoil is essential for improving the mined surfaces, which are devoid of organic matter, as these tend to crust. Surface temperatures are often high. Mulching with agricultural refuse, sugarcane refuse, pulpfibre, straw, sawdust, woodchips, cured hay, some chemicals, etc. alters the microclimate of the surface and help conserve moisture during the establishment of seedling.

Natural Colonizers

Plants appearing on abandoned mines and workings can be the potential species for reclamation. At higher altitudes, grasses, such as *Deschampsia caespitosa, Phleum alpinum* and *Poa alpina* perform better than the introduced species, and respond to fertilizers. *Rumex acetosella* is found on highly acidic soils where aluminium-and-manganese toxicity is coupled with induced deficiency of phosphorus. *Atriplex* spp, the SALTBUSH, are halophytes which tolerate the toxic substrates, such as alkaline and saline conditions. They show tolerance to aluminium and can also accumulate relatively high concentrations of iron, manganese and magnesium, but affected by deficiency of nitrogen. *A. nummularia* grows on nickel-rich wastes and other alkaline soils. *A. canescens* can be planted on open-cast uranium mines and coal-spoils. Other *Chenopodiaceae* members also may do well on sites high in soluble salts. *Robinia pseudoacacia* is considered to be the most acid-tolerant, and survives on spoils of lime, anthracite, sandwastes from zinc, lead, magnesium, iron, sulphur, coal, and brickwastes and spoilbanks of fireclay. *Quercus rubra* also is a pioneer-colonizer on brickwastes. *Populus tremula* grows on sandwastes and *P. alba* and *P. nigra* grow on marl-heaps. Cuttings of *Salix* spp are useful in stabilizing iron-mine slime and copper-tailings. *Betula* spp are typical pioneers, widely planted for reclamation. They tolerate low concentration of nutrients and once establish, they rapidly grow on moist or dry sites. *B. pendula* and *B. pubescens* are promising species to be grown on opencast rock-phosphate mine-sites. Other species, such as *B. papyrifera*, *B. pendula* and *Pinus sylvestris* perform well on very acidic spoils; *B. papyrifera* colonizes on asbestos wastes also. In India, grasses, such as *Cynodon* spp, and sedges, such as *Cyperus* spp, have been found growing on coal and allied mine-spoils preferably with moisture. *Typha* spp, *Cyperus* spp and also *Cynodon* spp are the only plants to naturally colonize the edges of drainage of tailing-dams.

Establishment of Vegetation

Restoration is an ecological process which needs the pioneer-species. Natural succession in such hostile mined areas is very often very slow, but can be achieved through self-sustaining vegetative cover by using these pioneer-species. Lower groups of plants are often first to appear. Grasses may form the first-stage growth. Early colonizers also include legumes, and other nitrogen-fixing plants or ectomycorrhizal trees. These may improve the site through their rootsystem, and the resultant organic matter gradully changes the texture of soil for further succession.

Succession of plants depends upon the availability of seed. Transplanting may be preferred if direct seeding becomes difficult. Factors inhibiting succession include acidity, heavy-metal toxicity, drought and lack of nutrients. The recommended precautions for restoration of natural vegetation are: (*i*) avoid cover-crops and widespread use of fertilizer; (*ii*) establish perennials in a nursery; (*iii*) use long brushwood and return topsoil; and (*iv*) plant the seedlings in the undergrowth along with balanced slow-release fertilizer near the seedlings. However, heavy initial application of fertilizer is commonly used where the establishment of cover or plantations are desired.

Use of Fertilizers

Restoration of natural fertility is a very long-drawn process without external intervention, whereas establishing the vegetation with fertilizer can quickly restore the fertility. Only slow-release fertilizers should be preferred.

Use of Micro-organisms and other soil-living Organisms

The use of algae, lichens and mosses in stabilization of tailings and other overburdens accelerates the establishment of higher species. These micro-organisms are important for recycling the nutrients. Inoculating with suitable, improved microflora including mycorrhiza, which are not sensitive to heavy-metal concentrations, is one of the important techniques. Bacteria and fungi may be helpful in breaking down the available organic matter and establising the green pioneers. The sludge can be used as organic manure to provide proper texture and microflora to the soil and to build up topsoil. It allows grasses to establish, and with good cultural practices and management, the yields of pastures, fodder and cereals, favourably compare with the yields from normal soils. Introducing earthworms, termites and other soil-living insects into the cycle of reclamation to improve the rate of incorporation of organic matter and porosity in soil has been suggested as a possibility in building up the topsoil.

Selection of Species

The selected species should be able to quickly grow and effectively stabilize and improve the soil and environment, besides being economically useful. On extreme sites, such as the mine-spoils, the range of plants is limited due to the toxicity. Mixtures of grasses rather than woody perennials can be sown with advantage as the grasses have short cycles of life and cover the area quickly. These often establish best with legumes or in established leguminous stands.

Festuca rubra in temperate climate, *Eragrostis curvula* in dry regions and *Chloris gayana* in the tropics are some grasses which tolerate low fertility and provide quick cover. *C. gayana* along with *Cenchrus ciliaris* and *Cynodon dactylon* is useful as a summer-cover on treated tailing-dams. *C. gayana, C. ciliaris* and *Panicum maximum* grow well on clayey coal-spoils with high *p*H and low content of nitrogen and phosphorus. *E. curvula*, a short-lived perennial, useful as a nurse, germinates easily and grows fast with a good rootsystem and tolerates acidic spoils and perform better than other grasses. In mixtures, *Bromus inermis*, *Dactylis glomerata* and *Phleum pratense* also survive. *Agrostis tenuis* and *Festuca ovina* are particularly suited to acid-metalliferous spoils containing lead, zinc and copper; *A. stolonifera*, *F. rubra* and *Plantago lanceolata* are suited to calcareous, metalliferous soils. *Anthoxanthum odoratum* tolerates zinc-rich wastes.

Species for improving Site

Legumes are important colonizers on abandoned spoils. Some woody legumes have been reported from Australia on bauxite mines. *Leucaena latisiliqua*, *Medicago sativa*, *Robinia pseudoacacia*, *Sarothamus scoparius* and also *Ulex europaeus* grow on several spoils; *M. sativa* prevents compaction. Other non-leguminous genera, capable of fixing nitrogen, include *Alnus* spp, *Casuarina* spp, *Elaeagnus* spp, *Hippophaë* spp and *Trema* spp; *Elaeagnus umbellata* and *Hippophaë rhamnoides* fix nitrogen, improve the soil and tolerate salinity, acid spoils; and the last species also shows best growth on white clay and carbonaceous clay-loam after open-cast coal-mining; it also grows on alkaline coal-spoils. *H. rhamnoides* produces suckers preventing erosion of slopes and helping the companion species. *Diplachne fusca* along with the nitrogen-fixing *Klebsiella pneumoniae* may also be suitable for saline, alkaline and waterlogged conditions. *Cynodon dactylon*, *Cyperus* spp, *Scilla hyacinthiana* and *Urginea indica* have been observed to grow on burnt and unburnt coal particularly in the presence of moisture. On lignite spoils, dumps and slopes, *R. pseudoacacia* and *H. rhamnoides* can be planted. Many *Eucalyptus* spp have been experimented and found to grow on various mine-spoils. *E.camaldulensis*, *E. citriodora*, *E. microtheca* and *E. tereticornis* are some important species which can be grown on mine-spoils. *E. camaldulensis* can be grown with success on tin-spoils. *Araucaria cunninghamii*, *Khaya senegalensis*, *Pinus sylvestris* and *Swietenia macrophylla* show promise on rock-phosphate spoils.

Species for Slimes

On tailings, which have soluble salts, phreatophytic, xerophytic or halophytic plants may be grown which can utilize the watertable at depth to withstand drought and tolerate salinity respectively. They should have not only deep but spreading rootsystem. *Acacia karroo*, *Euphorbia tirucalli* and *Tamarix aphylla* tolerate arsenic-rich wastes. *Casuarina glauca* grows well on arsenic-nickel and copper-rich wastes. Several *Acacia* spp, such as

A. melanoxylon, are used on slime-dumps as they act as windbreaks and reduce dust, trap seeds and provide cover for wildlife. *Acacia* spp should be given more importance in the reclamation of these lands as these are less demanding. Bauxite spoils of calcareous rocks can be planted with *Spartium junceum* on slopes. For opencast sites of manganese, species such as *Elaeagnus angustifolia, Pinus sylvestris* and *Robinia pseudoacacia* can be planted.

For reclaiming heavy-mineral and sand-mining areas, vegetation should be in three phases. Initially, a foredune is established using fences and grasses. When partially stabilized, the original grasses are thinned out and a mixture of legumes and grasses, comprising *Festuca rubra*, *Poa* spp and *Lupinus* spp, can be sown in the second phase. On some sites, woody shrubs, such as *Sarothamus scoparius*, can be planted. These may become nurse-crops for the third phase which may be large shrubs or trees. Reclamation of zircon and rutile mines from beach-sands can be done with *Cynodon dactylon* in the first phase, followed by creepers, such as *Canavalia maritima*, along with *Acacia saligna* and *Vitex trifolia*. Later *Casuarina equisetifolia* is very useful. *Phalaris arundinacea* can be grown for the control of erosion.

Hydroseeding

The seed can be sown direct or transplanted on difficult surfaces, such as steep slopes, sand-slopes and unstable materials through the use of water, called hydroseeding. Large volume of water, seed, fertilizer and mulch are needed to apply in a fine spray. Any shredded organic material, such as bark, sawdust, woodwool or hay, can be used to establish proper microclimate and to avoid clogging; and wood-mulch prevents soil-crusting. This technique is best suited particularly for grasses and is being successfully employed at Neyveli.

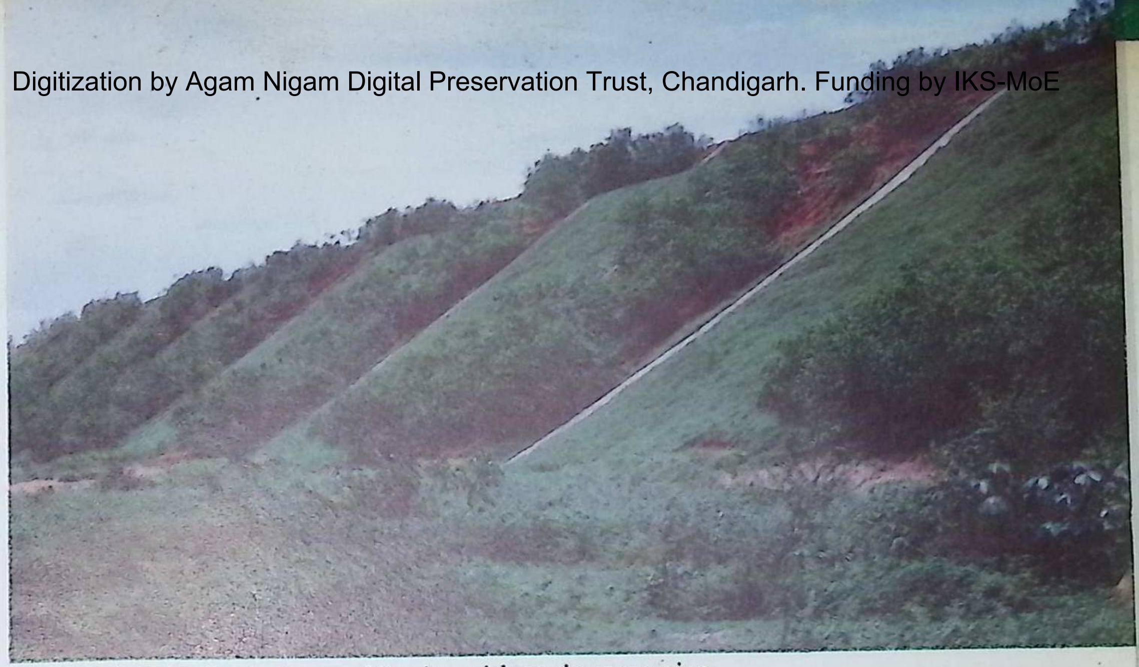
Reclamation Work in India

In India, reclamation of limestone and rock-phosphate mines in Dehra Dun and Mussoorie region has recently been started. Many species have been selected considering their utility. The plants found in the adjoining areas have been selected. Although stress was given to local species, exotic species have also been tried with success, depending upon site, climate and dump characteristics. It was suggested that barrier-zones with *Pinus* spp and *Cedrus* spp should also be established all round the mining areas in the Himalayas to prevent the dust-spread. The plants tried for stabilization of these mined areas in Dehra Dun are: *Acacia catechu, Adhatoda zeylanica, Ageratum conyzoides, Artemisia nilagarica (A.vulgaris), Arundo donax, Bauhinia retusa, B. vahlii, B. variegata, Bidens biternata, Blumea lacera,* *Buddleja asiatica, Callistemon viminalis, Cassia fistula, C. glauca, C. C. javanica, Cinnamomum camphora, Colebrookea oppositifolia, Dalbergia sissoo, Delonix regia, Erianthus* sp, *Gardenia jasminoides (G. florida), Jacaranda acutifolia, Lagerstroemia indica, Leucaena latisiliqua, Mallotus philippensis, Melia azedarach, Mimosa himalayana, Moringa oleifera, Murraya koenigii, Pennisetum purpureum* 'Hybrid Napier', *Pinus roxburghii, Rumex hastatus, Saccharum spontaneum, Salix tetrasperma, Trema politoria, Toona ciliata, Typha elephantina, Vitex negundo, Wendlandia exserta* and *Woodfordia fruticosa.*

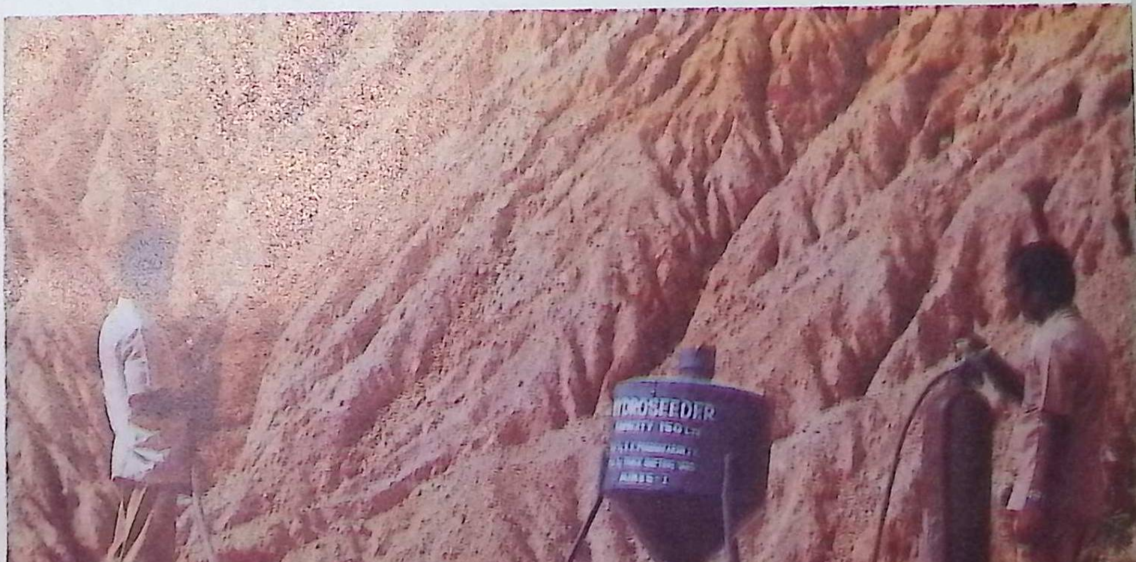
The most successful species among these are: *A. catechu, B. asiatica, D. sissoo, L. latisiliqua, M. himalayana, P. purpureum* 'Hybrid Napier', *R. hastatus, S. spontaneum, S. tetrasperma* and *V. negundo*. Species tried for stabilization of overburden dumps, mined slopes, stream-courses, etc. are: *Crotalaria spectabilis* (*C. sericea*), *Eriophorum comosum, Ipomoea carnea, L. latisiliqua, M. himalayana, Pinus caribaea* var. *bahamensis* 'Queensland Australia', var. *hondurensis* 'Brazil', 'Lostimones' and 'Poptunpaten Guatemala', *P. elliottii* 'Queensland Australia', *Rumex hastatus* and *S. tetrasperma.*

In India, coal-mining will be increasing from 200- million tonnes to a mind-boggling 2200-million tonnes by 2000 AD with corresponding overburdens. Likewise, the tailings and dumps from the mining of copper, iron ore, bauxite, etc. are equally reaching hazardous and uncontrollable volumes, and need reclamation. Reclamation work on bauxite, dolamite and coal overburden in Madhya Pradesh was taken up with *Grevillea pteridifolia* and found to be successful; the species is regenerating naturally. Recently, reclamation of opencast mine-spoils of lignite at Neyveli has been started and highly appreciated by the environmentalists. Some of the important trees which have been found to be successful on these spoils and created good cover are: *Acacia auriculaeformis, A. leucophloea, A. nilotica* ssp. *indica, Agave mexicana, Albizia lebbeck. Anacardium occidentale, Azadirachta indica, Cassia fistula, Casuarina equisetifoila, Ceiba pentandra, Dalbergia sissoo, Delonix regia, Dendrocalamus strictus, Derris indica, Eucalyptus citriodora, Eucalyptus* 'Hybrid', *Grevillea robusta, Lagerstroemia speciosa, Leucaena latisiliqua, Melia composita, Mimusops elengi, Parkia biglandulosa, Parkinsonia aculeata, Peltophorum pterocarpum, Polyalthia longifolia, Samanea saman, Sesbania grandiflora, Spathodea campanulata, Syzygium cuminii, Tabebuia rosea, Tamarindus indica* and *Tectona grandis*. Recently, a survey was conducted on the coalspoils of Talcher, Orissa, and the following species have been recorded growing and these may be useful for reclaiming such minespoils: *Acanthospermum hispidum, Acacia leucophloea, Adenosma indianum,* *Adina cordifolia*, *Aeschynomene indica*, *Ageratum conyzoides*, *Ailanthus excelsa*, *Alternanthera sessilis*, *Alstonia scholaris*, *Alysicarpus vaginalis*, *Ammania baccifera*, *Amberboa ramosa*, *Andrographis paniculata*, *Annona squamosa*, *Aristida setacea*, *Atylosia scarabaeoides*, *Azadirachta indica*, *Blumea alata* (= *Laggera alata*), *B. obliqua*, *Bombax ceiba*, *Borreria articularis*, *B. pusilla*, *Brassica rapa*, *Breynia rhamnoides*, *Bulbostylis barbata*, *Canscora diffusa*, *Casearia elliptica*, *Cassytha filiformis*, *Catharanthus roseus*, *Celosia argentea*, *Centella asiatica*, *Cleome viscosa*, *Commelina undulata*, *C. benghalensis*, *Croton bonplandianum*, *Dalbergia sissoo*, *Desmodium triflorum*, *Echinochloa colona*, *Eclipta prostrata*, *Eleusine indica*, *Eragrostis ciliaris*, *E. gangetica*, *E. unioloides*, *Euphorbia hirta*, *E. thymifolia*, *Ficus benghalensis*, *F. religiosa*, *Fimbristylis acuminata*, *F. aestivalis*, *Flacourtia indica*, *Gomphrena celosioides*, *Gymnema sylvestre*, *Hemidesmus indicus*, *Heteropogon contortus*, *Holarrhena antidysenterica*, *Hybanthus enneaspearmus*, *Hyptis suaveolens*, *Ichnocarpus frutescens*, *Indigofera linnaei*, *Ipomoea carnea*, *Ixora arborea*, *Kirganelia reticulata*, *Kyllinga triceps*, *Lantana camara* var. *aculeata*, *Leptadenia reticulata*, *Leucas aspera*, *L. lavandulaefolia* (*L. linifolia*), *Ludwigia perennis*, *Mitragyna parviflora*, *Morinda tomentosa*, *Ocimum basilicum*, *Oldenlandia corymbosa*, *Pennisetum pedicellatum*, *Phyllanthus niruri*, *P. simplex*, *Rotala serpyllifolia*, *Rostellularia diffusa*, *Saccharum spontaneum*, *Scoparia dulcis*, *Sebastiana chamaelea*, *Sida cordata*, *Solanum surattense*, *Sphenoclea zeylanica*, *Strychnos nuxvomica*, *Symplocos* spp, *Tamarindus indica*, *Tragia involucrata*, *Tridax procumbens*, *Triumfeta pentandra*, *Typha australis*, *Urena lobata*, *Vernonia cineria*, *Woodfordia fruticosa*, and *Ziziphus mauritiana.*

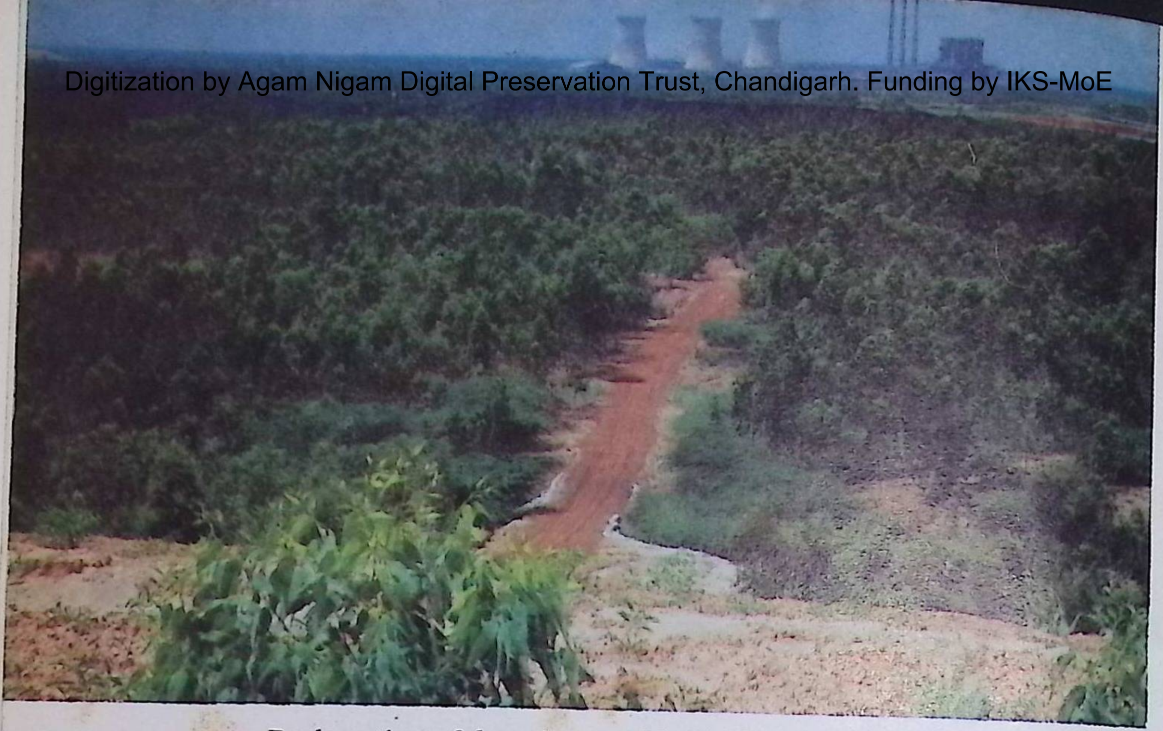
Unless, the mined areas are reclaimed with vigour, irrespective of other economic utility, these wastelands will further deteriorate and may encroach upon the fertile areas, particularly in dry and arid areas. Stringent laws should be enforced for reclamation when these areas are leased out for mining to prevent destruction. A detailed list of plants recorded from various sources is given in Appendix 12.



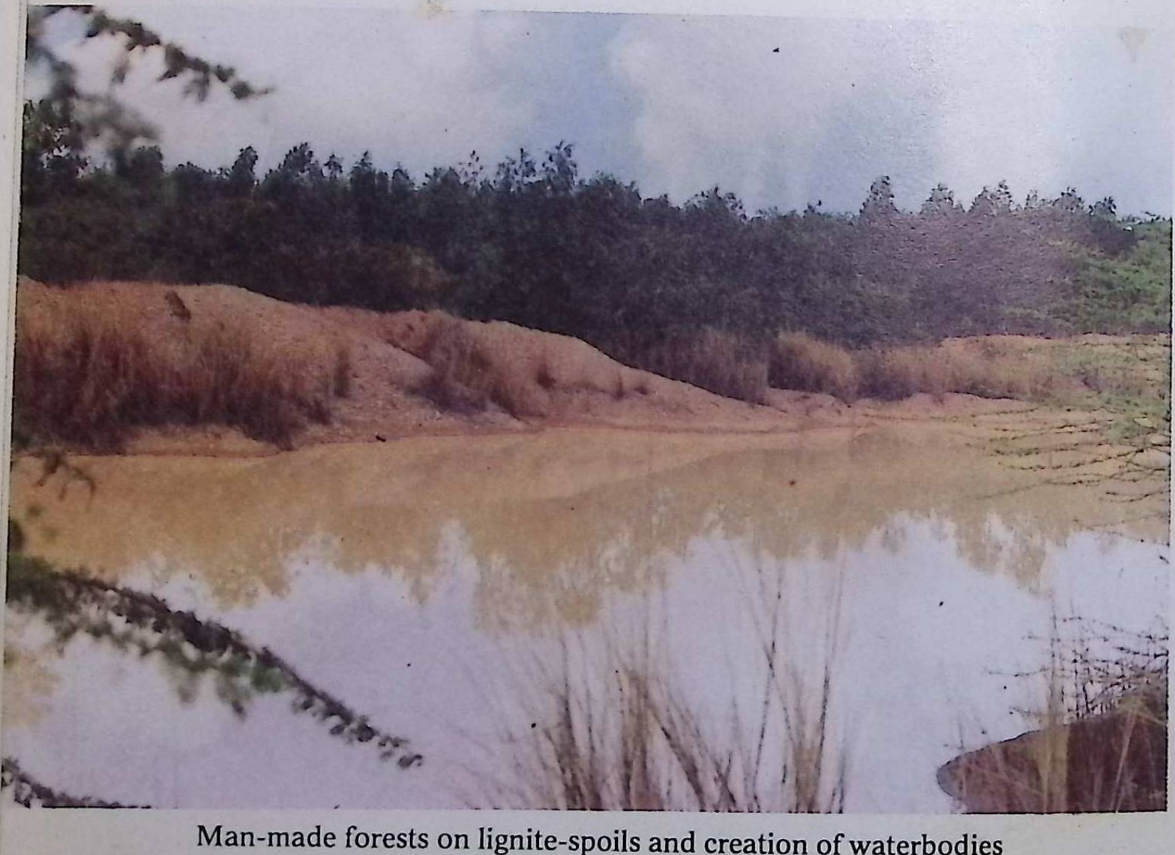
Consolidation of ash-slope of lignite with various species


HYDROSEEDER

Reclaiming minespoils through hydroseeding



Reclamation of dumping-yard in lignite mines



Man-made forests on lignite-spoils and creation of waterbodies

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APPENDICES

(Classified list of plants suitable for reclamation of various types of wastelands, and for timber, fuel, fodder, green manure, fixation of nitrogen, etc.)

1. Gullies and Ravines

Acacia auriculaeformis
  catechu
  leucophloea
  nilotica
Aegle marmelos
Aesculus indica
Agropyron cristatum
Ailanthus altissima
  excelsa
Alangium chinense
Albizia lebbeck
  odoratissima
  procera
Alysicarpus longifolius
Anacardium occidentale
Andropogon halli
  pumilus
Anogeissus latifolia
Apluda mutica
Artocarpus lakoocha
Azadirachta indica
Balanites roxburghii
Bauhinia semla
Betula alnoides
Bischofia javanica
Bombax ceiba
Broussonetia papyrifera
Capparis decidua
Cassia auriculata
  fistula
  siamea
Cenchrus ciliaris
Cordia dichotoma
Cynodon dactylon
Dalbergia sissoo
Dendrocalamus longispathus
  strictus
Derris indica
Dichanthium annulatum
  bladhii
  ischaemum
  pertusus
Dichrostachys cinerea
Digera muricata
Dodonaea viscosa
Eucalyptus brachypoda
  microtheca
Eucalyptus Hybrid
Eulaliopsis binata
Ficus glomerata
  semicordata
Flacourtia indica
Gliricidia sepium
Gmelina arborea
Haplophragma adenophyllum
Hippophaë rhamnoides
  salicifolia
Ischaemum pilosum
Leucaena latisiliqua
Limonia acidissima
Madhuca butyracea
Mangifera indica
Melia azedarach
Moringa oleifera
Morus alba
Panicum antidotale
  repens
  virgatum
Parkinsonia aculeata
Paspalum scorbiculatum

- *Phyllanthus fraternus*
- *Prosopis chilensis*
  - *cineraria*
- *Pueraria phaseoloides*
- *Punica granatum*
- *Saccharum bengalense*
- *Salix tetrasperma*
- *Salvadora persica*
- *Sapium sebiferum*
- *Schleichera oleosa*
- *Syzygium cuminii*
- *Tectona grandis*
- *Terminalia arjuna*
- *Ulmus wallichiana*

2. Salt-affected Lands (Saline, Sodic, Alkaline and Coastal Saline)

- *Acacia albida*
  - *aneura*
  - *auriculaeformis*
  - *bonariensis*
  - *catechu*
  - *cavenia*
  - *cyanophylla*
  - *cyclops*
  - *dealbata*
  - *erubescens*
  - *farnesiana*
  - *gerrardii*
  - *goetzei*
  - *greggii*
  - *hockii*
  - *holosericea*
  - *karroo*
  - *lenticularis*
  - *leucophloea*
  - *macrothyrsa*
  - *modesta*
  - *nilotica*
  - *pennata*
  - *polyacantha*
  - *pseudoeburnea*
  - *pycnantha*
  - *salicina*
  - *schweinfurthii*
  - *senegal*
  - *seyal*
  - *sinuata*
  - *tortilis*
- *Adenanthera pavonina*
- *Aegiceras corniculatum*
- *Agropyron cristatum*
- *Ailanthus excelsa*
- *Albizia procera*
- *Alstonia scholaris*
- *Alysicarpus longifolius*
  - *rugosus*
- *Anacardium occidentale*
- *Annona cherimola*
  - *glabra*
  - *reticulata*
  - *squamosa*
- *Areca catechu*
- *Argemone mexicana*
- *Aristida setacea*
- *Artemisia* spp
- *Arthrocnemum indicum*
- *Arundinella nepalensis*
- *Atriplex halimoides*
  - *hortensis*
  - *nummularia*
- *Azadirachta indica*
- *Barringtonia acutangula*
  - *racemosa*
- *Borassus flabellifer*
- *Brachiaria distachya*
  - *mutica*
- *Bruguiera parvi flora*
  - *sexangula*
- *Butea monosperma*
- *Caesalpinia bonduc*
- *Calophyllum inophyllum*
- *Calotropis gigantea*
  - *procera*
- *Capparis decidua*
- *Cassia auriculata*
  - *senna*
  - *siamea*
  - *tora*
- *Casuarina cristata*
  - *equisetifolia*

  glauca
  junghuhniana
Cenchrus biflorus
  ciliaris
  setigerus
Chenopodium album
Chloris barbata
  bournei
  gayana
  virgata
Chukrasia tabularis
Cleome vahliana
Celerodendrum inerme
Colophospermum mopane
Cordia dichotoma
Cressa cretica
Crotalaria medicaginea
Crotalaria spp
Cynodon dactylon
  plectostachyum
Cyperus corymbosus
  iria
  procerus
  rotundus
  scariosus
  stoloniferous
Dactyloctenium aegyptium
  scindicum
Dalbergia sissoo
Derris indica
Desmodium triflorum
Desmodium spp
Desmostachya bipinnata
Dichanthium annulatum
  aristatum
  parviflorum
Digitaria pentzii
Dinebra retroflexa
Diplachne fusca
Dodonaea viscosa
Echinochloa colonum
  crusgalli
  frumentacea
Eleusine indica
Emblica officinalis
Eragrostis coarctata
  curvula
  nutans
  plumosa
  viscosa
Erythrina corallodendron
Eucalyptus camaldulensis
  crebra
  deglupta
  ficifolia
  globulus
  gomphocephala
  goniocalyx
  grandis
  leucoxylon
  megacornata
  melanophloia
  microtheca
  morrisii
  occidentalis
  odorata
  populnea
  robusta
  rudis
  saligna
  siderophloia
  sideroxylon
  tereticornis
  terminalis
  tessellaris
  torelliana
Eucalyptus Hybrid
Euphorbia granulata
  tirucalli
Glaux maritima
Halopyrum mucronatum
Haloxylon recurvum
  salicornicum
Haplophragma adenophyllum
Heritiera minor
Heteropogon contortus
Hippophaë rhamnoides
  salicifolia
Holoptelea integrifolia
Indigofera cordifolia
  linifolia
Ipomoea pescaprae
  pestigridis
Ischaemum heterotrichum

- *muticum*
- *Iseilema prostratum*
- *Jatropha curcas*
  - *glandulifera*
- *Juncus articulatus*
  - *effusus*
  - *gerardii*
  - *rigidus*
- *Kochia indica*
- *Lablab purpureus*
- *Lannea coromandelica*
- *Lawsonia inermis*
- *Leptothrium senegalensis*
- *Leucaena latisiliqua*
- *Lopholepis ornithocephala*
- *Lotus corniculata*
- *Madhuca indica*
- *Melaleuca leucadendron*
- *Melilotus alba*
  - *indica*
- *Mesembryanthemum crystallinum*
- *Morus alba*
- *Myriostachya wightiana*
- *Ochthochloa compressa*
- *Opuntia dillenii*
  - *elatior*
  - *vulgaris*
- *Pandanus fascicularis*
- *Panicum antidotale*
  - *maximum*
  - *repens*
- *Paspalum notatum*
  - *scrobiculatum*
  - *vaginatum*
- *Phaseolus* spp
- *Phoenix dactylifera*
  - *sylvestris*
- *Pithecellobium dulce*
- *Pluchea lanceolata*
- *Populus alba*
  - *euphratica*
- *Populus* spp
- *Prosopis alba*
  - *chilensis*
  - *cineraria*
  - *pallida*
  - *stephaniana*
  - *tamarugo*
- *Prosopis* spp
- *Pseudoraphis spinescens*
- *Punica granatum*
- *Remirea maritima*
- *Rhizophora apiculata*
  - *mucronata*
- *Rhynchelytrum repens*
- *Rhynchosia minima*
- *Robinia pseudoacacia*
- *Rothia indica*
- *Salicornia brachiata*
- *Salsola baryosma*
  - *kali*
- *Salvadora oleoides*
  - *persica*
- *Sapium sebiferum*
- *Sarothamnus scoparius*
- *Schinus molle*
- *Scirpus tuberosus*
- *Sesbania bispinosa*
  - *cannabina*
  - *sesban*
  - *speciosa*
- *Simmondsia chinensis*
- *Sonneratia apetala*
  - *caseolaris*
- *Spinifex littoreus*
- *Sporobolus airoides*
  - *coromandelianus*
  - *helvolus*
  - *maderaspatanus*
  - *marginatus*
  - *nervosus*
  - *virginicus*
- *Stenotaphrum dimidiatum*
- *Stylosanthes guyanensis*
- *Suaeda fruticosa*
  - *maritima*
  - *monoica*
- *Syzygium cuminii*
- *Tamarindus indica*
- *Tamarix aphylla*
  - *dioica*
  - *troupii*
- *Tephrosia maxima*

- *Terminalia arjuna*
  - *bellirica*
  - *catappa*
- *Thespesia populnea*
- *Thuarea involuta*
- *Trifolium alexandrinum*
- *Trifolium* spp
- *Triphasia trifolia*
- *Ulex europaeus*
- *Vetiveria zizanioides*
- *Vitex trifolia*
- *Ziziphus jujuba*
  - *mauritiana*
  - *nummularia*
- *Zoysia matrella*
- *Zygophyllum simplex*

3. Surface-waterlogged, Marshy, Flooded Areas and Estuaries

- *Acacia nilotica*
  - *polyacantha*
  - *salicina*
  - *senegal*
- *Acanthus ilicifolius*
- *Acer negundo*
- *Acorus calamus*
- *Acrostichum aureum*
- *Actinodaphne angustifolia*
- *Aeschynomene aspera*
- *Agropyron cristatum*
- *Albizia lebbeck*
  - *procera*
- *Alternanthera sessilis*
- *Alysicarpus longifolius*
- *Ammannia baccifera*
- *Annona glabra*
- *Arundo donax*
- *Avicennia marina*
  - *officinalis*
- *Azadirachta indica*
- *Balanites roxburghii*
- Bamboos
- *Barringtonia acutangula*
  - *racemosa*
- *Bischofia javanica*
- *Borassus flabellifer*
- *Brachiaria mutica*
- *Bruguiera cylindrica*
  - *gymnorrhiza*
  - *parviflora*
  - *sexangula*
- *Butea monosperma*
- *Caesalpinia crista*
- *Calophyllum inophyllum*
- *Capparis decidua*
- *Carallia brachiata*
- *Cassia auriculata*
  - *fistula*
  - *senna*
  - *siamea*
  - *tora*
- *Casuarina equisetifolia*
- *Cenchrus biflorus*
- *Ceriops decandra*
  - *tagal*
- *Chenopodium album*
- *Chukrasia tabularis*
- *Cladium mariscus*
- *Clerodendrum inerme*
- *Clinogyne dichotoma*
- *Coix aquatica*
  - *gigantea*
- *Colocasia esculenta*
- *Colophospermum mopane*
- *Cordia dichotoma*
- *Crotalaria retusa*
- *Cymbopogon martinii*
- *Cynodon dactylon*
- *Cyperus alulatus*
  - *corymbosus*
  - *exaltatus*
  - *iria*
  - *malaccensis*
  - *pangorei*
  - *papyrus*
  - *procerus*
  - *rotundus*
- *Dalbergia latifolia*
- *Derris indica*
- *Desmostachya bipinnata*
- *Dichanthium annulatum*

Digera muricata
Diplachne fusca
Dodonaea viscosa
Donax arundinastrum
Echinochloa colona
frumentacea
stagnina
Eragrostis gangetica
pilosa
tenella
viscosa
Eucalyptus acmenioides
botryoides
calophylla
camaldulensis
citriodora
crebra
eugenioides
globulus
grandis
hemiphloia
microtheca
pilularis
propinqua
punctata
redunca
robusta
rudis
saligna
tereticornis
Eucalyptus Hybrid
Grevillea robusta
Haloxylon recurvum
Heritiera littoralis
minor
Ipomoea aquatica
pescaprae
Ischaemum muticum
rugosum
Jatropha curcas
Juncus effusus
inflexus
rigidus
Kandelia candel
Kyllinga brevifolia
Lagerstroemia hypoleuca
lanceolata
speciosa
Leptochloa chinensis
panicea
Leucaena latisiliqua
Madhuca indica
Mangifera indica
Mitragyna parvifolia
Morus alba
Nelumbo nucifera
Neptunia oleracea
Nymphaea alba
nouchali
stellata
Nymphoïdes cristatum
indicum
Nypa fruticans
Opuntia dillenii
elatior
vulgaris
Pandanus fascicularis
furcatus
Panicum antidotale
coloratum
miliaceum
repens
Pennisetum clandestinum
Phoenix paludosa
sylvestris
Phragmites australis
karka
Pinus patula
Polygonum plebeium
Polygonum spp
Populus deltoides
×euramericana
euphratica
Populus spp
Prosopis chilensis
cineraria
tamarugo
Pseudoraphis spinescens
Pterocarpus dalbergioides
Randia uliginosa
Raphia farinifera
Rhizophora apiculata
mucronata

- *Ricinus communis*
- *Robinia pseudoacacia*
- *Rumex dentatus*
  - *maritimus*
- *Saccharum bengalense*
  - *officinarum*
- *Sacciolepis interrupta*
- *Salicornia brachiata*
- *Salix alba*
  - *babylonica*
  - *fragilis*
  - *tetrasperma*
- *Salvadora oleoides*
  - *persica*
- *Samanea saman*
- *Sapium sebiferum*
- *Scirpus grossus*
  - *roylei*
- *Scirpus* spp
- *Sesbania bispinosa*
  - *cannabina*
  - *roxburghii*
  - *sesban*
  - *speciosa*
- *Sesuvium portulacastrum*
- *Sonneratia apetala*
  - *caseolaris*
- *Stylosanthes guyanensis*
- *Suaeda fruticosa*
  - *maritima*
- *Swietenia macrophylla*
- *Syzygium cuminii*
- *Tamarindus indica*
- *Tamarix aphylla*
  - *dioica*
  - *troupii*
- *Taxodium distichum*
- *Tephrosia noctiflora*
- *Terminalia alata*
- *Thespesia populnea*
- *Trema cannabina*
  - *orientalis*
- *Trewia nudiflora*
- *Typha australis*
  - *elephantina*
- *Typha* spp
- *Vetiveria zizanioides*
- *Xanthium strumarium*

4. Degraded Forestlands, Denuded Wastelands, Abandoned Lands, and Soil-binders

- *Abutilon indicum*
- *Acacia albida*
  - *catechu*
  - *constricta*
  - *cyclops*
  - *mellifera*
  - *nilotica*
  - *occidentalis*
  - *tortilis*
- *Acacia* spp
- *Acer campbellii*
  - *negundo*
- *Achyranthes aspera*
  - *bidentata*
- *Adhatoda zeylanica*
- *Aegiceras corniculatum*
- *Aeschynomene indica*
- *Agathis dammara*
- *Agave americana*
  - *angustifolia*
  - *cantala*
  - *mexicana*
  - *sisalana*
- *Agropyron acutum*
  - *cristatum*
  - *intermedium*
- *Agrostis canina*
  - *tenuis*
- *Ailanthus altissima*
  - *excelsa*
- *Alangium salviifolium*
- *Albizia amara*
  - *chinensis*
  - *distachya*
  - *falcataria*
  - *julibrissin*
  - *lebbek*
  - *procera*

- *Alloteropsis cimicina*
- *Alnus nepalensis*
  - *nitida*
- *Alstonia scholaris*
- *Alternanthera sessilis*
- *Altingia excelsa*
- *Alysicarpus longifolius*
  - *rugosus*
- *Amaranthus spinosus*
  - *viridis*
- *Anacardium occidentale*
- *Andropogon gayanus*
  - *hallii*
  - *pumilus*
- *Annona reticulata*
  - *squamosa*
- *Anogeissus latifolia*
- *Anthocephalus chinensis*
- *Apluda mutica*
- *Argemone mexicana*
- *Aristida depressa*
  - *plumosa*
  - *pungens*
- *Arthraxon quartinianus*
- *Arthrophyllum diversifolium*
- *Artocarpus heterophyllus*
  - *lakoocha*
- *Arundinella nepalensis*
- *Arundo donax*
- *Asystasia gangetica*
- *Atriplex patula*
- *Atylosia scarabaeoides*
- *Axonopus compressus*
- *Azadirachta indica*
- *Balanites roxburghii*
- Bamboos
- *Bambusa arundinacea*
- *Barleria acanthoides*
- *Bauhinia racemosa*
  - *semla*
- *Betula alnoides*
  - *cylindrostachys*
- *Bischofia javanica*
- *Boerhavia erecta*
- *Bombax ceiba*
- *Borassus flabellifer*
- *Boswellia serrata*
- *Bougainvillea* spp
- *Bouteloua gracilis*
- *Brachiaria brizantha*
  - *distachya*
  - *lata*
  - *mutica*
- *Bromus tectorum*
  - *unioloides*
- *Broussonetia papyrifera*
- *Buchloë dactyloides*
- *Bursera penicillata*
- *Butea monosperma*
- *Caesalpinia digyna*
- *Calliandra calothyrsus*
- *Calligonum polygonoides*
- *Calotropis acia*
  - *gigantea*
  - *procera*
- *Calotropis* spp
- *Canavalia maritima*
- *Carissa spinarum*
- *Cassia auriculata*
  - *fistula*
  - *montana*
  - *pumila*
  - *senna*
  - *siamea*
- *Cassia* spp
- *Casuarina equisetifolia*
  - *glauca*
  - *junghuhniana*
  - *obesa*
- *Catharanthus roseus*
- *Celtis laevigata*
- *Cenchrus biflorus*
  - *ciliaris*
  - *glaucus*
  - *setigerus*
- *Centrosema pubescens*
- *Chenopodium* spp
- *Chloris bournei*
  - *dolichostachya*
  - *gayana*
- *Chrysopogon aciculatus*
  - *fulvus*
- *Chrysopogon* sp
- *Chukrasia tabularis*

Citrullus colocynthis
Clerodendrum phlomoides
Clitoria ternatea
Colophospermum mopane
Commiphora wightii
Cordia myxa
Corylus colurna
Crotalaria burhia
Croton bonplandianum
Cryptomeria japonica
Cymbopogon caesius
coloratus
flexuosus
martinii
Cynodon dactylon
plectostachyum
Cyperus rotundus
rubicundus
scariosus
stoloniferous
Dactylis glomerata
Datura sp
Dendrocalamus strictus
Derris indica
Desmodium diffusum
heterocarpum
triflorum
Desmostachya bipinnata
Dichanthium annulatum
insculpta
Digera muricata
Digitaria ciliaris
longiflora
pentzii
Diospyros melanoxylon
Diplachne fusca
Dodonaea viscosa
Drymaria cordata
Dyerophytum indicum
Elaeagnus umbellata
Eleusine indica
Emblica officinalis
Eragrostis ciliaris
nigra
tenella
Eucalyptus alba
baueriana
bosistoana
botryoides
brachypoda
calophylla
camaldulensis
citriodora
deanei
deglupta
eugenioides
globulus
grandis
hemiphloia
melliodora
microtheca
occidentalis
paniculata
patens
patentinervis
pilularis
propinqua
punctata
redunca
robusta
rudis
saligna
siderophloia
sideroxylon
tereticornis
terminalis
Eucalyptus Hybrid
Eucalyptus sp
Eulaliopsis binata
Euphorbia caducifolia
Exbucklandia populnea
Fagopyrum esculentum
Festuca olgae
Furcraea foetida
Gardenia turgida
Garuga pinnata
Gleditsia triacanthos
Gloriosa superba
Gmelina arborea
Grevillea robusta
Grewia subinaequalis
Halopyrum mucronatum
Haloxylon multiflorum
salicornicum

- *Heteropogon contortus*
- *Hippophaë rhamnoïdes*
  - *salicifolia*
- *Holarrhena antidysenterica*
- *Holoptelea integrifolia*
- *Hydrocotyle javanica*
- *Hydrophylax maritima*
- *Imperata cylindrica*
- *Indigofera cordifolia*
  - *endecaphylla*
- *Ipomoea carnea*
  - *learii*
  - *obscura*
  - *pescaprae*
  - *pestigridis*
- *Ischaemum indicum*
  - *muticum*
  - *pilosum*
  - *rugosum*
  - *timorense*
- *Jatropha curcas*
  - *glandulifera*
  - *gossypifolia*
- *Kochia scoparia*
- *Kummerowia stipulacea*
- *Kydia calycina*
- *Lablab purpureus*
- *Lagerstroemia lanceolata*
- *Lannea coromandelica*
- *Lantana camara*
- *Lantana* spp
- *Lasiurus sindicus*
- *Lawsonia inermis*
- *Leucaena latisiliqua*
- *Lolium perenne*
- *Lotus corniculatus*
- *Lupinus angustifolius*
- *Maytenus emarginata*
- *Medicago hispida*
  - *sativa*
- *Melia composita*
- *Melilotus officinalis*
- *Mimosa pudica*
  - *scabrellae*
- *Morus alba*
- *Mucuna cochinchinensis*
- *Narenga porphyrocoma*
- *Neyraudia arundinacea*
- *Nypa fruticans*
- *Ochthochloa compressa*
- *Opuntia dillenii*
  - *elatior*
  - *vulgaris*
- *Orinus thoroldii*
- *Oxalis corniculata*
  - *martiana*
- *Pandanus fascicularis*
- *Panicum antidotale*
  - *maximum*
  - *repens*
  - *sumatrense*
  - *trypheron*
  - *turgidum*
- *Parthenium argentatum*
- *Paspalum conjugatum*
  - *dialatatum*
  - *notatum*
  - *vaginatum*
- *Pennisetum clandestinum*
  - *hohenackeri*
  - *pedicillatum*
  - *polystachyon*
- *Phacelurus speciosus*
- *Phalaris aquatica*
  - *arundinacea*
- *Phaseolus atropurpureus*
- *Phragmites communis*
  - *karka*
- *Pinus halepensis*
  - *merkusii*
- *Pithecellobium dulce*
- *Plantago ovata*
- *Poa compressa*
- *Populus alba*
  - *ciliata*
  - ×*euramericana*
  - *yunnanensis*
- *Populus* spp
- *Portulaca oleracea*
- *Portulaca* spp
- *Prosopis alba*
  - *chilensis*
  - –var. *glandulosa*
  - –var. *velutina*

cineraria
Prosopis spp
Pseudoraphis spinescens
Pseudotsuga menziesii
Pueraria lobata
phaseoloides
thomsonii
tuberosa
Punica granatum
Randia malabarica
Rhizophora apiculata
mucronata
~~Rhynchelytrum~~ repens
Rhynchosia minima
Ricinus communis
Robinia pseudoacacia
Rosa multiflora
Rumex acetosella
maritimus
Saccharum bengalense
spontaneum
Sacciolepis interrupta
Salix caprea
elegans
Salvadora oleoides
Salvia aegyptiaca
Schinus molle
Scirpus grossus
Scirpus spp
Sesbania bispinosa
cannabina
grandiflora
roxburghii
speciosa
Simmondsia chinensis
Sorbus aucuparia
Soymida febrifuga
Spartium junceum
Spinacia oleracea
Sporobolus diander
marginatus
nervosus
tremulus
Stereospermum suaveolens
Stylosanthes guyanensis
humilis
procumbens
scabra
sundaica
Stylosanthes spp
Suaeda fruticosa
maritima
Swietenia macrophylla
Tamarindus indica
Tamarix aphylla
Taxodium distichum
Tecoma stans
Tecomella undulata
Tectona grandis
Tephrosia candida
purpurea
Tetrapogon tenellus
Themeda anathera
triandra
Thespesia populnea
Thevetia peruviana
Thuarea involuta
Thuja occidentalis
Tilia cordata
Trema cannabina
politaria
Trewia nudiflora
Trianthema triquetra
Tribulus terrestris
Tricholaena teneriffae
Trifolium repens
Triphasia trifolia
Tripogon bromoides
Trisetum flavescens
Tussilago farfara
Typha elephantina
Ulex europaeus
Ulmus wallichiana
Urochloa mosambicensis
Vetiveria zizanioides
Vicia villosa
Vicoa indica
Vigna hosei
Vitex negundo
pinnata
Wightia speciosissima
Woodfordia fruticosa
Yucca gloriosa
Yucca spp

Ziziphus jujuba
mauritiana
nummularia
xylopyra

5. Degraded Pastures, Grazing-lands, Lawns, Turfs and Cover-crops

Acacia auriculaeformis
dealbata
decurrens
mearnsii
melanoxylon
nilotica
occidentalis
Aeschynomene americana
indica
Agropyron cristatum
repens
Agrostis canina
stolonifera
tenuis
Albizia chinensis
falcataria
odoratissima
richardiana
Alloteropsis cimicina
Alysicarpus belgaumensis
rugosus
Anthocephalus chinensis
Arundinella nepalensis
Arundo donax
Asystasia gangetica
Axonopus compressus
Azadirachta indica
Bambusa balcooa
brandisii
vulgaris
Bombax ceiba
Brachiaria decumbens
distachya
mutica
ramosa
Bromus unioloides
Buchloë dactyloides
Butea monosperma
Calligonum polygonoides
Canavalia maritima
Cassia tora
Casuarina equisetifolia
Cenchrus biflorus
ciliaris
setigerus
Centrosema pubescens
Chenopodium album
Chenopodium sp
Chloris barbata
bournei
gayana
virgata
Chrysopogon aciculatus
fulvus
serrulatus
Chrysopogon sp
Chukrasia tabularis
Clitoria ternatea
Cressa cretica
Crotalaria burhia
retusa
Crotalaria spp
Cymbopogon caesius
coloratus
Cynodon dactylon
plectostachyum
Dactylis glomerata
Dactyloctenium aegyptium
Dalbergia latifolia
sissoo
Derris indica
Desmodium diffusum
heterocarpum
tortuosum
triflorum
Desmodium spp
Desmostachya bipinnata
Dichanthium annulatum
aristatum
bladhii
caricosum
parviflorum

pertusus
Dichrostachys cinerea
Digera muricata
Digitaria longiflora
pentzii
Drymaria cordata
Echinochloa colona
frumentacea
Elusine indica
Eragrostis coarctata
curvula
nutans
superba
viscosa
Eremopogon foveolatus
Erythrina indica
Eucalyptus grandis
Eulaliopsis binata
Fagopyrum esculentum
Festuca rubra
Ficus glomerata
Gloriosa superba
Heteropogon contortus
Imperata cylindrica
Indigofera cordifolia
endecaphylla
Ipomoea obscura
pestigridis
Ischaemum rugosum
Iseilema laxum
Kydia calycina
Lablab purpureus
Lantana camara
Lasiurus hirsutus
sindicus
Leucaena latisiliqua
Lolium perenne
Lotus corniculatus
Lupinus angustifolius
Mangifera indica
Medicago hispida
sativa
Melilotus alba
indica
Mimosa pudica
Mucuna cochinchinensis
deeringiana
pruriens
Ochthochloa compressa
Opuntia dillenii
elatior
Oxalis latifolia
Panicum antidotale
maximum
miliaceum
repens
trypheron
turgidum
Paspalum conjugatum
notatum
Pennisetum clandestinum
pedicellatum
polystachyon
Phalaris aquatica
Phaseolus atropurpureus
Phaseolus spp
Pinus patula
Poa compressa
Poa spp
Populus spp
Portulaca oleracea
Portulaca spp
Prosopis chilensis
cineraria
Pseudoraphis spinescens
Pterocarpus marsupium
Pterygota alata
Pueraria phaseoloides
tuberosa
Rhynchosia minima
Rumex acetosella
Saccharum bengalense
spontaneum
Salvadora oleoides
persica
Samanea saman
Schinus molle
Sesbania cannabina
sesban
Spinacea oleracea
Sporobolus airoides
coromandelianus
helvolus
marginatus

  stocksii
  tremulus
Stenotaphrum dimidiatum
Stereospermum suaveolens
Stylosanthes fruticosa
  guyanensis
  procumbens
  scabra
  sundaica
Stylosanthes spp
Suaeda maritima
Swietenia macrophylla
Syzygium cuminii
Tephrosia candida
  hookeriana
  singapou
  tinctoria
  vogelii
Tephrosia spp
Themeda anathera
Tragus roxburghii
Trianthema triquetra
Trifolium alexandrinum
  repens
Trifolium spp
Trisetum flavescens
Ulex europaeus
Urochloa mosambicensis
Vicia villosa
Vicoa indica
Vigna hosei
Wightia speciosissima
Ziziphus nummularia
  xylopyra
Zoysia matrella

6. Striplands (Roads and Railways, Canalbunds, Riverbanks) Shade- and Avenue-trees, Wind- and Firebreaks, Shelterbelts and Fences

Acacia aneura
  auriculaeformis
  cavenia
  decurrens
  farnesiana
  jacquemontii
  latronum
  lenticularis
  mearnsii
  melanoxylon
  moniliformis
  nilotica
  salicina
  senegal
  tortilis
Acorus calamus
Aegle marmelos
Aeschynomene aspera
Agave americana
  angustifolia
  cantala
  vera-cruz
Agropyron repens
Ailanthus altissima
  excelsa
Albizia amara
  falcataria
  lebbeck
  procera
Alhagi pseudalhagi
Alloteropsis cimicina
Alnus nepalensis
  nitida
Anacardium occidentale
Annona glabra
Arthrophyllum diversifolium
Artocarpus lakoocha
Arundo donax
Atriplex nummularia
Axonopus compressus
Azadirachta indica
Balanites roxburghii
Bamboos
Bambusa burmanica
  glaucescens
  guadua
  nutans
  vulgaris
Barringtonia racemosa

Bauhinia purpurea
tomentosa
variegata
Betula alnoides
Bischofia javanica
Boerhavia erecta
Bombax ceiba
Borassus flabellifer
Boswellia serrata
Bridelia airy-shawii
Buchloë dactyloides
Caesalpinia bonduc
Calligonum polygonoides
Calophyllum inophyllum
Calotropis gigantea
procera
Canavalia maritima
Capparis decidua
Carissa carandus
Cassia auriculata
occidentalis
siamea
Casuarina cristata
equisetifolia
glauca
obesa
Celtis australis
Cenchrus biflorus
ciliaris
setigerus
Ceratonia siliqua
Chrysopogon aciculatus
fulvus
Cladium mariscus
Clerodendrum inerme
Cochlospermum religiosum
Colocasia esculenta
Commiphora berryi
caudata
Cordia dichotoma
Cymbopogon martinii
Cynodon dactylon
plectostachyum
Cyperus malaccensis
pangorei
Dactyloctenium australe
Dalbergia latifolia
sissoo
sympathetica
Delonix elata
regia
Dendrocalamus hamiltonii
Derris indica
Desmodium triflorum
Dichanthium annulatum
caricosum
Dodonaea viscosa
Echinochloa frumentacea
stagnina
Erythrina indica
Eucalyptus camaldulensis
gomphocephala
marginata
microtheca
paniculata
robusta
tereticornis
Eucalyptus Hybrid
Eucalyptus spp
Eulaliopsis binata
Euphorbia neriifolia
nivulia
royleana
tirucalli
Ficus beng(h)alensis
glomerata
religiosa
semicordata
Flacourtia indica
Furcraea foetida
Garuga pinnata
Gleditsia triacanthos
Gliricidia sepium
Grevillea robusta
Hardwickia binata
Hippophaë rhamnoides
salicifolia
Ipomoea carnea
learii
obscura
pestigridis
Ischaemum muticum
rugosum
Iseilema laxum

APPENDIX 6

- *Jatropha curcas*
- *Juglans regia*
- *Juniperus macropoda*
- *Kochia indica*
- *Kyllinga brevifolia*
- *Lagerstroemia speciosa*
- *Lawsonia inermis*
- *Leptochloa chinensis*
  - *panicea*
- *Leucaena latisiliqua*
- *Madhuca longifolia*
- *Melia azedarach*
- *Mimosa himalayana*
- *Morus alba*
  - *serrata*
- *Nastus guadua*
- *Opuntia dillenii*
  - *elatior*
  - *vulgaris*
- *Ougeinia oojeinensis*
- *Pandanus fascicularis*
  - *furcatus*
- *Panicum antidotale*
  - *turgidum*
- *Parkinsonia aculeata*
- *Parthenium argentatum*
- *Pennisetum clandestinum*
  - *hohenackeri*
  - *polystachyon*
- *Phoenix paludosa*
  - *sylvestris*
- *Pinus halepensis*
- *Pithecellobium dulce*
- *Platanus orientalis*
- *Populus ciliata*
  - *euphratica*
  - *×euramericana*
  - *laurifolia*
  - *nigra*
- *Populus* spp
- *Prosopis chilensis*
  - *cineraria*
- *Pterocarpus marsupium*
- *Pterygota alata*
- *Randia malabarica*
- *Rhizophora mucronata*
- *Ricinus communis*
- *Robinia pseudoacacia*
- *Rosa multiflora*
- *Rumex maritimus*
- *Saccharum bengalense*
  - *spontaneum*
- *Sacciolepis interrupta*
- *Salix alba*
  - *babylonica*
  - *caprea*
  - *wallichiana*
- *Salvadora oleoides*
  - *persica*
- *Samanea saman*
- *Sapium sebiferum*
- *Schinus molle*
- *Schleichera oleosa*
- *Scirpus grossus*
  - *roylei*
- *Sehima nervosum*
- *Sesbania cannabina*
  - *grandiflora*
  - *roxburghii*
  - *sesban*
  - *speciosa*
- *Spinifex littoreus*
- *Sporobolus maderaspatanus*
  - *marginatus*
  - *tremulus*
- *Syncarpia glomulifera*
- *Syzygium cuminii*
- *Tamarindus indica*
- *Tamarix aphylla*
  - *dioica*
  - *troupii*
- *Tecoma stans*
- *Tecomella undulata*
- *Tectona grandis*
- *Tephrosia candida*
- *Tephrosia maxima*
  - *vogelii*
- *Terminalia catappa*
  - *chebula*
- *Thespesia populnea*
- *Thevetia peruviana*
- *Thuja occidentalis*
  - *plicata*

Tilia cordata
Trema cannabina
  orientalis
Ulex europaeus
Ulmus wallichiana
Urochloa mosambicensis
Vetiveria zizanioides
Vitex negundo
  pinnata
  trifolia
Woodfordia fruticosa
Yucca gloriosa
Yucca spp
Ziziphus jujuba
  mauritiana
  nummularia
  oenoplia
  xylopyra

7. Sandy Areas (Arid, Semi-arid Areas, Sand-dunes, etc.)

Acacia albida
  aneura
  auriculaeformis
  catechu
  cyanophylla
  cyclops
  dealbata
  eburnea
  farnesiana
  greggii
  hockii
  jacquemontii
  leucophloea
  mangium
  mearnsii
  mellifera
  modesta
  nilotica
  nubica
  planifrons
  salicina
  senegal
  sentis
  sieberiana
  tortilis
Acanthus ilicifolius
Adhatoda zeylanica
Aerva pseudotomentosa
Agave americana
Agropyron cristatum
Ailanthus excelsa
  triphysa
Albizia amara
  chinensis
  lucida
  procera
Alloteropsis cimicina
Aloe barbadensis
Alysicarpus rugosus
Amaranthus spinosus
Andropogon pumilus
Annona cherimola
  reticulata
  squamosa
Anogeissus latifolia
  pendula
Apluda mutica
Aristida cyanantha
  depressa
  funiculata
  hystricula
  mutabilis
  plumosa
  pungens
Artemisia spp
Arundo donax
Atriplex canescens
  confertifolia
  halimus
  hortensis
  nummularia
  nuttalis
  semibeccata
  vesicaria
Atriplex spp
Azadirachta indica
Balanites roxburghii
Bamboos
Bauhinia racemosa
Blepharis sindica

Boswellia serrata
Brachiaria ramosa
Bromus tectorum
  unioloides
Bursera penicillata
Butea monosperma
Calligonum polygonoides
Calotropis gigantea
  procera
Capparis decidua
Cassia auriculata
  fistula
  pumila
  senna
  siamea
  tora
Casuarina cristata
  equisetifolia
  junghuhniana
Catharanthus roseus
Cenchrus ciliaris
  echinatus
  glaucus
  pennisetiformis
  prieurii
Ceratonia siliqua
Chloris barbata
  bournei
  virgata
Chrysopogon aciculatus
  aucheri
  serrulatus
Chrysopogon sp
Citrullus colocynthis
  lanatus
Clitoria ternatea
Colophospermum mopane
Commiphora wightii
Cordia dichotoma
  gharaf
Cressa cretica
Crotalaria burhia
Crypsis schoenoides
Cymbopogon jwarancusa
  parkerii
  schoenanthus
Cynodon dactylon

Cyperus arenarius
  bulbosus
  compressus
  cuspidatus
  laevigatus
  pulchellus
  rotundus
Dactylis glomerata
Dactyloctenium aegyptium
  australe
Dalbergia sissoo
Dendrocalamus strictus
Derris indica
Desmodium tortuosum
Desmostachya bipinnata
Dichanthium annulatum
  caricosum
Dichrostachys cinerea
Digera muricata
Digitaria ciliaris
Dipterygium glaucum
Echinochloa frumentacea
Elaeagnus angustifolia
Ephedra gerardiana
Eragrostiella bifaria
Eragrostis ciliaris
  plumosa
  superba
  tremula
  trichioides
Eremopogon foveolatus
Eucalyptus behriana
  brachypoda
  camaldulensis
  citriodora
  coolabah
  dealbata
  eremophila
  erythronema
  flocktoniae
  gomphocephala
  intertexta
  lansdowneana
  largiflorens
  lesouefii
  melanophloia

microtheca
occidentalis
ochrophloea
oleosa
populnea
rudis
salmonophloia
salubris
sideroxylon
stricklandii
tereticornis
terminalis
torquata
transcontinentalis
viridis
wandoo
Euphorbia caducifolia
granulata
neriifolia
nivulia
Fagonia cretica
Farsetia jacquemontii
Ficus beng(h)alensis
Hackelochloa granularis
Haloxylon salicornicum
Haplophragma adenophyllum
Hardwickia binata
Hippophaë rhamnoides
salicifolia
Holoptelea integrifolia
Indigofera cordifolia
endecaphylla
linifolia
Ipomoea pescaprae
Ischaemum pilosum
Iseilema laxum
Jatropha curcas
gossypifolia
Juncus rigidus
Kochia indica
Kochia spp
Kydia calycina
Lablab purpureus
Lagerstroemia hypoleuca
Lasiurus hirsutus
sindicus
Leptadenia pyrotechnica
Leptothrium senegalensis
Leucaena latisiliqua
Limonia acidissima
Lopholepis ornithocephala
Madhuca longifolia
Maytenus emarginata
Melanocenchris jacquemontii
Morus alba
Mucuna deeringiana
pruriens
Neurada procumbens
Ochthochloa compressa
Opuntia dillenii
elatior
vulgaris
Orinus thoroldii
Ougeinia oojeinensis
Pandanus fascicularis
Panicum antidotale
maximum
miliaceum
miliare
repens
sumatranse
trypheron
turgidum
Parkinsonia aculeata
Parthenium argentatum
Pennisetum hohenackeri
mezianum
orientale
Phoenix dactylifera
sylvestris
Phyllanthus fraternus
Pinus halepensis
thunbergii
Pithecellobium dulce
Plantago ovata
Pluchea lanceolata
Populus euphratica
Prosopis alba
chilensis
– var. *glandulosa*
– var. *velutina*
cineraria
pallida
tamarugo

- *Prosopis* spp
- *Punica granatum*
- *Rhynchosia minima*
- *Ricinus communis*
- *Saccharum bengalense*
  - *spontaneum*
- *Salsola baryosma*
- *Salvadora oleoides*
  - *persica*
- *Sarothamnus scoparius*
- *Schinus molle*
- *Sehima ischaemoides*
  - *nervosum*
  - *sulcatum*
- *Sesbania cannabina*
  - *grandiflora*
  - *sesban*
  - *speciosa*
- *Sesuvium portulacastrum*
- *Simmondsia chinensis*
- *Spergula arvensis*
- *Sporobolus diander*
  - *helvolus*
  - *maderaspatanus*
  - *spicatus*
  - *tremulus*
  - *virginicus*
- *Stylosanthes guyanensis*
  - *procumbens*
- *Tamarindus indica*
- *Tamarix aphylla*
  - *dioica*
  - *ericoides*
  - *troupii*
- *Tecoma stans*
- *Tecomella undulata*
- *Tephrosia purpurea*
- *Terminalia arjuna*
- *Tetrapogon tenellus*
- *Themeda anathera*
- *Thevetia peruviana*
- *Tragus roxburghii*
- *Trianthema triquetra*
- *Tribulus terrestris*
- *Tricholaena teneriffae*
- *Trifolium alexandrinum*
- *Vetiveria zizanioides*
- *Xanthium strumarium*
- *Yucca gloriosa*
- *Ziziphus jujuba*
  - *mauritiana*
  - *nummularia*
  - *spinachristii*
- *Zoysia matrella*

8. Cold Deserts

- *Bromus unioloides*
- *Crataegus oxyacantha*
- *Deschampsia caespitosa*
- *Eucalyptus acmenioides*
  - *aggregata*
  - *bridgesiana*
  - *cineria*
  - *coccifera*
  - *dalrympleana*
  - *delegatensis*
  - *gunnii*
  - *johnstonii*
  - *niphophila*
  - *ovata*
  - *parviflora*
  - *racemosa*
  - *regnans*
  - *robusta*
  - *vernicosa*
- *Festuca rubra*
- *Juglans regia*
- *Juniperus communis*
  - *macropoda*
  - *wallichiana*
- *Kochia prostrata*
- *Lolium perenne*
- *Medicago sativa*
- *Melilotus officinalis*
- *Phleum alpinum*
- *Poa alpina*
- *Populus alba*
  - *balsamifera*
  - *euphratica*
  - *lasiocarpa*

laurifolia
nigra
Pyracantha crenulata
Robinia pseudoacacia
Rosa multiflora
Rosa spp
Salix alba
daphnoides
flabellaris
fragilis
hastata
wallichiana
Stipa jacquemontii
Tamarix troupii
Trifolium pratense
Trisetum flavescens
Ulex europaeus

9. Barren, Rocky, Stony, Gravelly, Hill and Acidic Soils

Acacia auriculaeformis
catechu
dealbata
ferruginea
latronum
mangium
mearnsii
melanoxylon
mellifera
nilotica
occidentalis
senegal
tortilis
Adhatoda zeylanica
Adina cordifolia
Aerva persica
Agropyron repens
Albizia amara
distachya
julibrissin
odoratissima
Aleurites fordii
Alhagi pseudalhagi
Alnus nepalensis
Alstonia scholaris
Alysicarpus vaginalis
Anacardium occidentale
Annona reticulata
squamosa
Anogeissus latifolia
pendula
rotundifolia
Apluda mutica
Aristida hystricula
Arthraxon lancifolius
Artocarpus heterophyllus
Axonopus compressus
Azadirachta indica
Bamboos
Barleria acanthoides
Bauhinia purpurea
semla
Betula alnoides
cylindrostachys
Boerhavia diffusa
Bonamia latifolia
Boswellia serrata
Brachiaria brizantha
Buchanania lanzan
Buddleja asiatica
Bursera penicillata
Butea monosperma
Calliandra calothrysus
Calotropis gigantea
procera
Capparis decidua
spinosa
Carissa spinarum
Cassia auriculata
fistula
nigricans
pumila
siamea
tora
Casuarina leptoclada
littoralis
paludosa
stricta
Cenchrus ciliaris
setigerus
Centrosema pubescens
Ceratonia siliqua

Chloris virgata
Chrysopogon aucheri
  fulvus
  gryllus
  lancearius
  serrulatus
Chukrasia tabularis
Citrullus lanatus
Cleome scaposa
  vahliana
Cochlospermum religiosum
Commiphora wightii
Coriaria nepalensis
Crotalaria burhia
Cryptomeria japonica
Cymbopogon caesius
  flexuosus
Cynodon dactylon
Cyperus rotundus
  rubicundus
Dactyloctenium scindicum
Dalbergia latifolia
  sissoo
  sympathetica
Dendrocalamus longispathus
  strictus
Deschampsia flexuosa
Desmodium heterocarpum
  triflorum
Dichanthium annulatum
  armatum
  ischaemum
  parviflorum
  pertusus
Dichrostachys cinerea
Digera muricata
Digitaria ciliaris
Dodonaea viscosa
Drymaria cordata
Dyerophytum indicum
Elaeagnus angustifolia
  umbellata
Emblica officinalis
Ephedra foliata
Eragrostiella bifaria
Eragrostis nigra
Eucalyptus acmenioides
  bicolor
  botryoides
  calophylla
  camaldulensis
  citriodora
  cladocalyx
  cornuta
  crebra
  deglupta
  dives
  eugenioides
  exserta
  ficifolia
  globulus
  gomphocephala
  goniocalyx
  grandis
  gummifera
  gunnii
  hemiphloia
  leucoxylon
  longifolia
  macror(r)hyncha
  maidenii
  melliodora
  microcarpa
  microcorys
  muellerana
  obliqua
  paniculata
  pilularis
  piperita
  planchoniana
  polyanthemos
  propinqua
  punctata
  redunca
  regnans
  resinifera
  robusta
  rudis
  saligna
  siderophloia
  sideroxylon
  tereticornis
  viminalis
Eucalyptus Hybrid

Eulaliopsis binata
Euphorbia caducifolia
  granulata
  neriifolia
  royleana
Exbucklandia populnea
Fagonia cretica
Fagopyrum esculentum
Festuca olgae
  rubra
Ficus glomerata
Gardenia turgida
Gliricidia sepium
Grevillea robusta
Grewia tenax
Hackelochloa granularis
Hardwickia binata
Heteropogon contortus
Hippophaë rhamnoides
  salicifolia
Indigofera endecaphylla
Ischaemum timorense
  tumidum
Jatropha gossypifolia
Juncus rigidus
Lagerstroemia lanceolata
Lannea coromandelica
Lantana camara
Leptadenia pyrotechnica
Leucaena latisiliqua
Madhuca butyracea
Maytenus emarginata
Melaleuca leucadendron
Melanocenchris jacquemontii
Melia composita
Mimosa scabrellae
Mundulea sericea
Ochthochloa compressa
Opuntia dillenii
  elatior
  vulgaris
Ougeinia oojeinensis
Oxalis corymbosa
Panicum maximum
  miliaceum
  sumatrense
Parkinsonia aculeata
Pennisetum clandestinum
Phalaris aquatica
  minor
Pinus gerardiana
  merkusii
  taeda
  thunbergii
Populus alba
  ciliata
  ×*euramericana*
  euphratica
  nigra
  robusta
  yunnanensis
Prosopis chilensis
  cineraria
Prunus cerasoides
Pseudoraphis spinescens
Pueraria lobata
  thomsonii
Punica granatum
Pyracantha crenulata
Quillaja saponaria
Rhynchelytrum repens
Robinia pseudoacacia
Rumex hastatus
Salix alba
Salvadora oleoides
Salvia aegyptiaca
Sapium sebiferum
Sarothamnus scoparius
Schinus molle
Schleichera oleosa
Sehima ischaemoides
Sesbania grandiflora
  sesban
Simmondsia chinensis
Soymida febrifuga
Sporobolus diander
Stereospermum suaveolens
Stylosanthes guyanensis
  procumbens
  scabra
Tamarindus indica
Tamarix troupii
Tephrosia purpurea
Themeda anathera

triandra
Thevetia peruviana
Trema cannabina
orientalis
politaria
Trewia nudiflora
Tribulus terrestris
Ulex europaeus
Ulmus wallichiana
Vigna hosei
Vitex negundo
pinnata
trifolia
Wendlandia exserta
Wightia speciosissima
Woodfordia fruticosa
Xanthium strumarium
Yucca gloriosa
Ziziphus nummularia
xylopyra

10. Green Manures and Nitrogen-fixers

Acacia albida
aneura
auriculaeformis
bonariensis
catechu
cavenia
constricta
cyanophylla
cyclops
dealbata
decurrens
erubescens
farnesiana
gerrardii
goetzii
karroo
leucophloea
macrothyrsa
mangium
mearnsii
melanoxylon
mellifera
nilotica ssp. indica
pennata
polyacantha
pycnantha
salicina
senegal
seyal
sieberiana
tortilis
Adhatoda zeylanica
Aeschynomene americana
Albizia amara
chinensis
distachya
falcataria
julibrissin
lebbeck
odoratissima
procera
Alhagi pseudalhagi
Alnus nepalensis
nitida
Alysicarpus longifolius
monilifer
rugosus
vaginalis
Argemone mexicana
Atylosia scarabaeoides
Azadirachta indica
Bamboos
Bauhinia purpurea
racemosa
tomentosa
Bischofia javanica
Borassus flabellifer
Caesalpinia crista
Caesalpinia spp
Cajanus cajan
Calotropis gigantea
procera
Canavalia ensiformis
maritima
Cassia auriculata
didymobotrya
fistula
grandis
hirsuta
javanica

  leschenaultiana
  mimosoides
  nigricans
  occidentalis
  pumila
  siamea
  sophora
  tora
Cassia spp
Casuarina equisetifolia
  junghuhniana
Centrosema pubescens
Cleome chelidonii
Clitoria ternatea
Crotalaria anagyroides
  burhia
  juncea
  retusa
Crotalaria spp
Croton bonplandianum
Cyamopsis tetragonoloba
Dalbergia latifolia
  sissoo
Derris indica
Desmodium diffusum
  heterocarpum
  tortuosum
  triflorum
Dichrostachys cinerea
Diplachne fusca
Dodonaea viscosa
Elaeagnus angustifolia
  umbellata
Erythrina corallodendron
  indica
Fagopyrum esculantum
Gleditsia triacanthos
Gliricidia sepium
Hippophaë rhamnoides
  salicifolia
Indigofera cordifolia
  endecaphylla
  glandulosa
  hirsuta
  linifolia
  tinctoria
  uniflora
Ipomoea aquatica
  carnea
Jatropha curcus
Kandelia candel
Kummerowia stipulacea
  striata
Kydia calycina
Lablab purpureus
Lantana camara
Lantana spp
Lathyrus sativa
Leucaena latisiliqua
Lotus corniculatus
Lupinus angustifolius
Medicago hispida
  sativa
Melilotus alba
  indica
  officinalis
Mimosa hamata
  pudica
  scabrellae
Moringa oleifera
Mucuna cochinchinensis
  deeringiana
  pruriens
Mundulea sericea
Neptunia oleracea
Opuntia dillenii
  elatior
Opuntia spp
Ougeinia oojeinensis
Oxalis corniculata
  corymbosa
  latifolia
Phaseolus atropurpureus
Pinus taeda
Pithecellobium dulce
Prosopis spp
Pterocarpus dalbergioides
  marsupium
Pueraria lobata
  phaseoloides
  thomsonii
  tuberosa
Rhynchosia minima
Rhynchosia spp

- *Robinia pseudoacacia*
- *Rothia indica*
- *Samanea saman*
- *Sarothamnus scoparius*
- *Scirpus grossus*
- *Sesbania bispinosa*
  - *cannabina*
  - *grandiflora*
  - *roxburghii*
  - *sesban*
  - *speciosa*
- *Spartium junceum*
- *Spergula arvensis*
- *Tamarindus indica*
- *Tephrosia candida*
  - *hookeriana*
  - *maxima*
  - *procumbens*
  - *purpurea*
  - *singapou*
  - *tinctoria*
  - *villosa*
  - *vogelii*
- *Tephrosia* spp
- *Thespesia populnea*
- *Trema* spp
- *Trifolium alexandrinum*
  - *pratense*
  - *repens*
- *Ulex europaeus*
- *Vicia villosa*
- *Vigna aconitifolia*
  - *hosei*
  - *radiata*
  - *trilobata*
- *Voandzeia subterranea*
- *Wrightia tinctoria*
- *Xanthium strumarium*

11. Potential Hydrocarbon-yielding Plants

- *Acokanthera spectabilis*
- *Alstonia scholaris*
- *Antidesma bunius*
- *Argyreia nervosa*
- *Artocarpus chaplasha*
  - *communis*
  - *lakoocha*
- *Asclepias curassavica*
- *Bridelia stipularis*
- *Calotropis gigantea*
  - *procera*
- *Caralluma fimbriata*
- *Claoxylon polot*
- *Croton oblongifolius*
- *Cryptostegia grandiflora*
- *Decalepis hamiltonii*
- *Dregea volubilis*
- *Euphorbia acualis*
  - *antiquorum*
  - *antisyphilitica*
  - *caducifolia*
  - *geniculata*
  - *helioscopia*
  - *heterophylla*
  - *hirta*
  - *lathyris*
  - *marginata*
  - *neriifolia*
  - *nivulia*
  - *royleana*
  - *segetalis*
  - *thymifolia*
  - *tirucalli*
  - *trigona*
- *Excoecaria agallocha*
- *Ficus carica*
  - *elastica*
  - *glomerata*
- *Glochidion hohenackeri*
  - *multiloculare*
  - *thomsonii*
- *Hemidesmus indicus*
- *Homonoia riparia*
- *Hoya parasitica*
- *Jatropha curcas*
- *Kirganelia lineata*
- *Leptadenia reticulata*
- *Madhuca longifolia* var. *latifolia*
- *Manilkara hexandra*
- *Mimusops elengi*
- *Pedilanthus tithymaloides*
- *Pergularia daemia*

Plumeria alba
Putranjiva roxburghii
Sapium sebiferum
Suregada multiflora
Tabernaemontana divaricata
Thevetia peruviana
Wrightia tinctoria
  tomentosa

12. Mined and Industrial Wastelands

Acacia auriculaeformis
  catechu
  dealbata
  jacquemontii
  karroo
  leucophloea
  melanoxylon
  nilotica
  salicina
  senegal
Acacia spp
Acanthospermum hispidum
Adenosma indianum
Adhatoda zeylanica
Adina cordifolia
Aeschynomene indica
Agave mexicana
  sisalana
  vera-cruz
Ageratum conyzoides
Agropyron cristatum
Agrostis stolonifera
  tenuis
Ailanthes excelsa
Albizia falcataria
  lebbeck
  procera
Alnus spp
Alstonia scholaris
Alternanthera sessilis
Alysicarpus longifolius
  vaginalis
Ammania baccifera
Anacardium occidentale
Andrographis paniculata
Annona squamosa
Anogeissus rotundifolia
Anthoxanthum odoratum
Araucaria cunninghamii
Aristida setacea
Arundo donax
Atriplex canescens
  nummularia
Atriplex spp
Atylosia scarabaeoides
Azadirachta indica
Bauhinia semla
  vahlii
  variegata
Betula papyrifera
  pendula
  pubescens
Betula spp
Bidens biternata
Blumea alata
  lacera
  obliqua
Bombax ceiba
Borreria articularis
  pusilla
Brassica rapa
Breynia rhamnoides
Bromus inermis
Buddleja asiatica
Bulbostylis barbata
Calligonum polygonoides
Callistemon viminalis
Canavalia maritima
Canscora diffusa
Casearia elliptica
Cassia fistula
  javanica
  spectabilis
  surattensis
  tora
Cassytha filiformis
Casuarina equisetifolia
  glauca
Casuarina spp
Catharanthus roseus
Ceiba pentandra
Cedrus spp

- *Celosia argentea*
- *Celtis laevigata*
- *Cenchrus biflorus*
  - *ciliaris*
  - *setigerus*
- *Centella asiatica*
- *Chenopodium album*
- *Chloris gayana*
- *Chrysothamnus nauseosus*
- *Cinnamomum camphora*
- *Cleome viscosa*
- *Colebrookia oppositifolia*
- *Commelina benghalensis*
  - *undulata*
- *Crotalaria spectabilis*
- *Croton bonplandianus*
- *Cymbopogon citratus*
- *Cynodon dactylon*
- *Cynodon* spp
- *Cyperus* spp
- *Dactylis glomerata*
- *Dalbergia sissoo*
- *Delonix regia*
- *Dendrocalamus strictus*
- *Derris indica*
- *Deschampsia caespitosa*
- *Desmodium triflorum*
- *Dichanthium annulatum*
- *Dodonaea viscosa*
- *Echinochloa colona*
- *Eclipta prostrata*
- *Elaeagnus angustifolia*
  - *umbellata*
- *Elaeagnus* spp
- *Eleusine indica*
- *Emblica officinalis*
- *Eragrostis ciliaris*
  - *curvula*
  - *gangetica*
  - *unioloides*
- *Erianthus* sp
- *Eriophorum comosum*
- *Erythrina corallodendron*
- *Eucalyptus camaldulensis*
  - *citriodora*
  - *grandis*
  - *microtheca*
  - *robusta*
  - *tereticornis*
- *Eucalyptus* spp
- *Euphorbia hirta*
  - *thymifolia*
  - *tirucalli*
- *Fagonia cretica*
- *Festuca ovina*
  - *rubra*
- *Ficus beng(h)alensis*
  - *religiosa*
- *Fimbristylis acuminata*
  - *aestivalis*
- *Flacourtia indica*
- *Gardenia jasminoides*
- *Gleditsia triacanthos*
- *Gliricidia sepium*
- *Gomphrena celosioides*
- *Grevillea pteridifolia*
  - *robusta*
- *Gymnema sylvestre*
- *Hemidesmus indicus*
- *Heteropogon contortus*
- *Hippophaë rhamnoides*
  - *salicifolia*
- *Holarrhena antidysenterica*
- *Hybanthus enneaspearmus*
- *Hyptis suaveolens*
- *Ichnocarpus frutescens*
- *Indigofera linnaei*
- *Ipomoea aquatica*
  - *carnea*
- *Ixora arborea*
- *Jacaranda acutifolia*
- *Khaya senegalensis*
- *Kirganelia reticulata*
- *Kyllinga triceps*
- *Lagerstroemia indica*
  - *speciosa*
- *Lantana camara* var.*aculeata*
- *Leptadenia reticulata*
- *Leucaena latisiliqua*
- *Leucas aspera*
  - *linifolia*
- *Lolium perenne*
- *Ludwigia perennis*
- *Lupinus* spp

Madhuca longifolia
Mallotus philippensis
Medicago sativa
Melaleuca leucadendron
Melia azedarach
  composita
Mimosa himalayana
Mimusops elengi
Mitragyna parviflora
Moringa oleifera
Morinda tomentosa
Murraya koenigii
Nyssa sylvatica
Ochthochloa compressa
Ocimum basilicum
Oldenlandia corymbosa
Oligochaeta ramosa
(Amberboa ramosa)
Opuntia dillenii
  elatior
  vulgaris
Oryzopsis hymenoides
Panicum maximum
  repens
  turgidum
Parkia biglandulosa
Parkinsonia aculeata
Paspalum vaginatum
Peltophorum pterocarpum
Pennisetum pedicellatum
  purpureum
Phalaris arundinacea
Phleum alpinum
  pratense
Phyllanthus fraternus
  simplex
Picea sitchensis
Pinus caribaea
  elliottii
  roxburghii
  sylvestris
  taeda
Pinus spp
Plantago lanceolata
Platanus orientalis
Poa alpina
Poa spp

Polyalthia longifolia
Polygonum plebeium
Populus alba
  nigra
  suaveolens
  tremuloides
  tremula
Populus spp
Punica granatum
Quercus rubra
Raphia farinifera
Robinia pseudoacacia
Rostellularia diffusa
Rotala serpyllifolia
Rumex acetosella
  hastatus
Saccharum spontaneum
Salix caprea
  tetrasperma
Salix spp
Salvadora oleoides
  persica
Samanea saman
Sarothamnus scoparius
Scilla hyacinthiana
Scoparia dulcis
Sebastiania chamaelea
Sesbania grandiflora
Sida cordata
Solanum surattense
Spartium junceum
Spathodea campanulata
Sphenoclea zeylanica
Sporobolus virginicus
Strychnos nuxvomica
Swietenia macrophylla
Symplocos spp
Syzygium cuminii
Tabebuia rosea
Tamarindus indica
Tamarix aphylla
Tectona grandis
Thuja occidentalis
  plicata
Tilia cordata
Toona ciliata
Tragia involucrata

- *Trema politaria*
- *Tridax procumbens*
- *Trifolium repens*
- *Triumfetta pentandra*
- *Typha australis*
  - *elephantina*
- *Typha* spp
- *Ulex europaeus*
- *Urena lobata*
- *Urginea indica*
- *Vernonia cineria*
- *Vitex negundo*
  - *trifolia*
- *Wendlandia exserta*
- *Woodfordia fruticosa*
- *Ziziphus mauritiana*
  - *nummularia*

13. Agro- and Social-forestry Plants

- *Acacia albida*
  - *catechu*
  - *leucophloea*
  - *mearnsii*
  - *moniliformis*
  - *modesta*
  - *nilotica*
  - *senegal*
  - *sinuata*
  - *tortilis*
- *Adenanthera pavonina*
- *Adhatoda zeylanica*
- *Adina cordifolia*
- *Aegle marmelos*
- *Aesculus indica*
- *Agave americana*
- *Ailanthus altissima*
  - *excelsa*
  - *triphysa*
- *Albizia chinensis*
  - *falcataria*
  - *julibrissin*
  - *lebbeck*
  - *procera*
  - *richardiana*
- *Alnus nepalensis*
  - *nitida*
- *Alstonia scholaris*
- *Anacardium occidentale*
- *Annona reticulata*
  - *squamosa*
- *Anthocephalus chinensis*
- *Artocarpus heterophyllus*
  - *lakoocha*
- *Arundo donax*
- *Azadirachta indica*
- Bamboos
- *Bambusa arundinacea*
- *Bauhinia purpurea*
  - *racemosa*
- *Betula cylindrostachys*
- *Bischofia javanica*
- *Bombax ceiba*
- *Borassus flabellifer*
- *Bougainvillea* spp
- *Brachiaria mutica*
- *Bridelia airy-shawii*
- *Buchanania lanzan*
- *Butea monosperma*
- *Calliandra calothyrsus*
- *Calophyllum inophyllum*
- *Carissa carandus*
- *Cassia fistula*
  - *siamea*
- *Casuarina equisetifolia*
- *Catharanthus roseus*
- *Celtis australis*
- *Chukrasia tabularis*
- *Corylus colurna*
- *Crotalaria juncea*
- *Cymbopogon flexuosus*
  - *jwarancusa*
  - *martinii*
- *Cynodon dactylon*
  - *plectostachyum*
- *Dalbergia latifolia*
  - *sissoo*
- *Delonix elata*
  - *regia*
- *Dendrocalamus strictus*

- *Diospyros melanoxylon*
- *Dodonaea viscosa*
- *Emblica officinalis*
- *Erythrina indica*
- *Eucalyptus camaldulensis*
  - *grandis*
  - *tereticornis*
- *Eucalyptus* Hybrid
- *Eulaliopsis binata*
- *Exbucklandia populnea*
- *Ficus glomerata*
  - *religiosa*
- *Garuga pinnata*
- *Gliricidia sepium*
- *Gmelina arborea*
- *Grevillea robusta*
- *Grewia elastica*
  - *subinaequalis*
- *Haplophragma adenophyllum*
- *Hardwickia binata*
- *Holoptelea integrifolia*
- *Ipomoea pescaprae*
- *Juglans regia*
- *Lagerstroemia duperreana*
  - *hypoleuca*
  - *speciosa*
- *Lannea coromandelica*
- *Leucaena latisiliqua*
- *Madhuca butyracea*
  - *indica*
  - *longifolia*
- *Mangifera indica*
- *Medicago sativa*
- *Melia azedarach*
- *Moringa oleifera*
- *Morus alba*
  - *serrata*
- *Ougeinia oojeinensis*
- *Panicum antidotale*
  - *repens*
- *Parkinsonia aculeata*
- *Phoenix sylvestris*
- *Pithecellobium dulce*
- *Populus alba*
  - *balsamifera*
  - *deltoides*
  - *euphratica*
  - *lasiocarpa*
  - *laurifolia*
  - *tremuloides*
  - *yunnanensis*
- *Populus* spp
- *Prosopis cineraria*
- *Pterocarpus dalbergioides*
- *Pterygota alata*
- *Ricinus communis*
- *Robinia pseudoacacia*
- *Salix alba*
  - *babylonica*
  - *fragilis*
  - *tetrasperma*
- *Samanea saman*
- *Sapium sebiferum*
- *Sesbania bispinosa*
  - *cannabina*
  - *roxburghii*
  - *sesban*
- *Stereospermum suaveolens*
- *Swietenia mahagoni*
- *Syzygium cuminii*
- *Tamarindus indica*
- *Taxodium distichum*
- *Tecoma stans*
- *Tectona grandis*
- *Terminalia alata*
  - *arjuna*
  - *bellirica*
  - *catappa*
- *Thespesia populnea*
- *Thevetia peruviana*
- *Trewia nudiflora*
- *Vitex negundo*
- *Wendlandia exserta*
- *Wrightia tinctoria*
- *Ziziphus jujuba*
  - *mauritiana*

14. Timber

- *Acacia albida*
  - *auriculaeformis*
  - *catechu*
  - *decurrens*

eburnea
farnesiana
ferruginea
latronum
lenticularis
leucophloea
mangium
mearnsii
melanoxylon
mellifera
modesta
nilotica
planifrons
polyacantha
senegal
tortilis
Acer campbellii
Adenanthera pavonina
Adina cordifolia
Aegiceras corniculatum
Aegle marmelos
Aesculus indica
Ailanthus altissima
excelsa
Alangium chinense
salviifolium
Albizia amara
chinensis
lebbeck
lucida
odoratissima
procera
Albizia spp
Alnus nepalensis
nitida
Alstonia scholaris
Altingia excelsa
Annona glabra
reticulata
squamosa
Anogeissus latifolia
pendula
Anogeissus spp
Anthocephalus chinensis
Artocarpus lakoocha
Avicennia marina
Azadirachta indica
Balanites roxburghii
Bamboos
Bambusa arundinacea
vulgaris
Barringtonia acutangula
Bauhinia purpurea
racemosa
semla
tomentosa
variegata
Betula alnoides
cylindrostachyus
Bischofia javanica
Bombax ceiba
Borassus flabellifer
Boswellia serrata
Bridelia airy-shawii
Broussonetia papyrifera
Bruguiera cylindrica
gymnorrhiza
parviflora
Buchanania lanzan
Bursera penicillata
Butea monosperma
Calophyllum inophyllum
Capparis decidua
Carallia brachiata
Carissa carandus
Cassia fistula
montana
siamea
spectabilis
Casuarina cristata
equisetifolia
junghuhniana
Celtis australis
Ceratonia siliqua
Ceriops decandra
tagal
Chukrasia tabularis
Colophospermum mopane
Cordia dichotoma
gharaf
Coriaria nepalensis
Crataegus oxyacantha
Cryptomeria japonica
Dalbergia latifolia

sissoo
Dalbergia spp
Delonix elata
Dendrocalamus hamiltonii
longispathus
strictus
Derris indica
Dichrostachys cinerea
Dodonaea viscosa
Emblica officinalis
Erythrina indica
Eucalyptus acmenioides
aggregata
bicolor
bridgesiana
camaldulensis
cineria
citriodora
coccifera
crebra
dalrympleana
delegatensis
diversicolor
eugenioides
ficifolia
globulus
gomphocephala
goniocalyx
gummifera
gunnii
hemiphloia
johnstonii
leucoxylon
longifolia
macror(r)hyncha
maidenii
melliodora
microcarpa
microtheca
niphophila
obliqua
occidentalis
ovata
paniculata
parviflora
pilularis
polyanthemos
propinqua
punctata
racemosa
redunca
regnans
resinifera
robusta
rudis
saligna
siderophloia
sideroxylon
tereticornis
vernicosa
viminalis
Eucalyptus spp
Euphorbia nivulia
tirucalli
Exbucklandia populnea
Ficus beng(h)alensis
glomerata
religiosa
Flacourtia indica
Gardenia turgida
Garuga pinnata
Gleditsia triacanthos
Gliricidia sepium
Gmelina arborea
Grevillea robusta
Grewia elastica
tenax
tillifolia
Haplophragma adenophyllum
Hardwickia binata
Heritiera littoralis
minor
Holarrhena antidysenterica
Holoptelea integrifolia
Juglans regia
Juniperus communis
macropoda
wallichiana
Kandelia candel
Kydia calycina
Lagerstroemia hypoleuca
lanceolata
speciosa
Lannea coromandelica

Leucaena latisiliqua
Limonia acidissima
Madhuca butyracea
  longifolia
Mangifera indica
Maytenus emarginata
Melaleuca leucadendron
Melia azedarach
Mimosa himalayana
Mitragyna parvifolia
Moringa oleifera
Morus alba
  serrata
Nyssa sylvatica
Ougeinea oojeinensis
Phoenix dactylifera
  sylvestris
Picea sitchensis
Pinus gerardiana
  halepensis
  merkusii
  patula
  roxburghii
  taeda
  thunbergii
Pithecellobium dulce
Platanus orientalis
Populus alba
  ciliata
  deltoides
  euphratica
  lasiocarpa
  laurifolia
  nigra
  robusta
Populus spp
Prosopis alba
  chilensis
  cineraria
  pallida
  tamarugo
Prosopis spp
Prunus cerasoides
Pseudotsuga menziesii
Pterocarpus dalbergioides
  marsupium
Pterygota alata
Pyracantha crenulata
Randia uliginosa
Rhizophora apiculata
  mucronata
Robinia pseudoacacia
Salix alba
  babylonica
  daphnoides
  elegans
  flabellaris
  tetrasperma
Salvadora oleoides
  persica
Samanea saman
Sapium sebiferum
Schleichera oleosa
Sesbania grandiflora
  roxburghii
  sesban
  speciosa
Sonneratia apetala
  caseolaris
Soymida febrifuga
Stereospermum suaveolens
Swietenia macrophylla
  mahagoni
Syncarpia glomulifera
Syzygium cuminii
Tamarindus indica
Tamarix aphylla
  troupii
Taxodium distichum
Tecomella undulata
Tectona grandis
Terminalia alata
  arjuna
  bellirica
  catappa
  chebula
Themeda triandra
Tilia cordata
Trema cannabina
  orientalis
Triphasia trifolia
Ulmus wallichiana
Wendlandia exserta

- *Wightia speciosissima*
- *Wrightia tinctoria*
- *Ziziphus jujuba*
  - *mauritiana*
  - *xylopyra*

15. Fuel

- *Acacia albida*
  - *auriculaeformis*
  - *catechu*
  - *dealbata*
  - *decurrens*
  - *eburnea*
  - *farnesiana*
  - *jacquemontii*
  - *latronum*
  - *leucophloea*
  - *mangium*
  - *mearnsii*
  - *melanoxylon*
  - *mellifera*
  - *moniliformis*
  - *modesta*
  - *nilotica*
  - *planifrons*
  - *polyacantha*
  - *pycnantha*
  - *senegal*
  - *seyal*
  - *tortilis*
- *Adenanthera pavonina*
- *Adhatoda zeylanica*
- *Adina cordifolia*
- *Aegiceras corniculatum*
- *Aeschynomene aspera*
- *Agropyron cristatum*
- *Alangium salviifolium*
- *Albizia amara*
  - *chinensis*
  - *julibrissin*
  - *lebbeck*
  - *procera*
- *Albizia* spp
- *Alnus nepalensis*
- *Anogeissus latifolia*
  - *pendula*
- *Anogeissus* spp
- *Avicennia officinalis*
- *Balanites roxburghii*
- *Barringtonia acutangula*
- *Bauhinia semla*
  - *tomentosa*
  - *variegata*
- *Betula alnoides*
  - *cylindrostachys*
- *Bischofia javanica*
- *Borassus flabellifer*
- *Boswellia serrata*
- *Bougainvillea* spp
- *Bruguiera cylindrica*
  - *gymnorrhiza*
  - *parviflora*
- *Buchanania lanzan*
- *Butea monosperma*
- *Calliandra calothyrsus*
- *Calligonum polygonoides*
- *Calotropis procera*
- *Cassia fistula*
  - *montana*
  - *siamea*
- *Casuarina equisetifolia*
  - *junghuhniana*
- *Ceriops decandra*
  - *tagal*
- *Cochlospermum religiosum*
- *Colophospermum mopane*
- *Cordia gharaf*
- *Dalbergia sissoo*
- *Dalbergia* spp
- *Derris indica*
- *Dichrostachys cinerea*
- *Diospyros melanoxylon*
- *Diplachne fusca*
- *Dodonaea viscosa*
- *Elaeagnus angustifolia*
  - *umbellata*
- *Emblica officinalis*
- *Ephedra gerardiana*
- *Eucalyptus acmenioides*
  - *aggregata*
  - *bicolor*

bridgesiana
calophylla
camaldulensis
cineria
citriodora
coccifera
dalrympleana
delegatensis
ficifolia
globulus
gomphocephala
goniocalyx
gunnii
hemiphloia
johnstonii
longifolia
macror(r)hyncha
maidenii
melliodora
microcarpa
microcorys
microtheca
niphophila
obliqua
occidentalis
ovata
paniculata
parviflora
pilularis
racemosa
regnans
resinifera
robusta
rudis
saligna
sideroxylon
tereticornis
vernicosa
viminalis
Eucalyptus spp
Euphorbia royleana
Exbucklandia populnea
Fagopyrum esculentum
Gardenia turgida
Garuga pinnata
Gleditsia triacanthos
Gliricidia sepium
Grevillea robusta
Grewia elastica
tiliifolia
Hardwickia binata
Heritiera littoralis
minor
Hippophaë rhamnoides
salicifolia
Holoptelea integrifolia
Juniperus communis
macropoda
Kandelia candel
Kochia indica
Kydia calycina
Lagerstroemia lanceolata
Leucaena latisiliqua
Madhuca indica
longifolia
Mangifera indica
Melia azedarach
Mimosa himalayana
scabrellae
Morus alba
Ougeinia oojeinensis
Parkinsonia aculeata
Phoenix dactylifera
Pithecellobium dulce
Populus alba
ciliata
euphratica
laurifolia
nigra
Populus spp
Prosopis chilensis
cineraria
Prosopis spp
Prunus cerasoides
Pterocarpus dalbergioides
marsupium
Pterygota alata
Quercus sp
Randia malabarica
Rhizophora apiculata
mucronata
Ricinus communis
Robinia pseudoacacia
Salix alba

caprea
daphnoides
elegans
flabellaris
fragilis
tetrasperma
Salvadora oleoides
persica
Sapium sebiferum
Sesbania grandiflora
sesban
Sonneratia apetala
Spinifex littoreus
Stereospermum suaveolens
Suaeda fruticosa
Syzygium cuminii
Tamarindus indica
Tamarix aphylla
dioica
ericoides
Tectona grandis
Terminalia alata
arjuna
bellirica
chebula
Thespesia populnea
Tilia cordata
Trema cannabina
orientalis
Triphasia trifolia
Ulex europaeus
Woodfordia fruticosa
Xanthium strumarium
Ziziphus mauritiana
nummularia
xylopyra.

16. Fodder

Acacia albida
catechu
dealbata
jacquemontii
leucophloea
melanoxylon
mellifera
nilotica
polyacantha
salicina
senegal
seyal
tortilis
Acanthus ilicifolius
Actinodaphne angustifolia
Adina cordifolia
Aegle marmelos
Aerva persica
Aeschynomene aspera
indica
Aesculus indica
Agropyron cristatum
repens
Agrostis canina
stolonifera
Ailanthus excelsa
Alangium chinense
Albizia amara
chinensis
lebbeck
odoratissima
Albizia spp
Alhagi pseudalhagi
Alnus nepalensis
Alternanthera sessilis
Alysicarpus longifolius
rugosus
vaginalis
Andropogon gayanus
hallii
pumilus
Annona reticulata
squamosa
Anogeissus latifolia
pendula
Anogeissus spp
Anthocephalus chinensis
Anthoxanthum odoratum
Apluda mutica
Aristida cyanantha
depressa
funiculata

hystricula
plumosa
pungens
Artemisia spp
Arthraxon lancifolius
quartinianus
Artocarpus heterophyllus
lakoocha
Arundinella nepalensis
Arundo donax
Atriplex halimus
nummularia
Avicennia officinalis
Axonopus compressus
Azadirachta indica
Balanites roxburghii
Bambusa arundinacea
vulgaris
Barleria acanthoides
Barringtonia acutangula
Bauhinia purpurea
racemosa
semla
variegata
Blepharis sindica
Boerhavia diffusa
Bombax ceiba
Borassus flabellifer
Bothriochloa intermedia
Bouteloua gracilis
Brachiaria brizantha
deflexa
distachya
lata
mutica
ramosa
Bridelia airy-shawii
Bromus inermis
tectorum
unioloides
Broussonetia papyrifera
Buchanania lanzan
Buchloë dactyloides
Butea monosperma
Caesalpinia bonduc
digyna
Calliandra calothyrsus
Calligonum polygonoides
Calotropis gigantea
procera
Capparis decidua
spinosa
Carallia brachiata
Carissa spinarum
Cassia fistula
siamea
tora
Celtis australis
Cenchrus biflorus
ciliaris
echinatus
glaucus
pennisetiformis
prieurii
setigerus
Centrosema pubescens
Ceratonia siliqua
Chenopodium album
Chenopodium sp
Chloris barbata
bournei
gayana
virgata
Chrysopogon aciculatus
aucheri
fulvus
gryllus
lancearius
serrulatus
Chrysopogon sp
Chukrasia tabularis
Clitoria ternatea
Coix aquatica
gigantea
Colophospermum mopane
Corylus colurna
Crotalaria burhia
juncea
Cymbopogon caesius
citratus
coloratus
flexuosus
jwarancusa
parkerii

schoenanthus
Cynodon dactylon
plectostachyum
Cyperus alulatus
iria
Dactylis glomerata
Dactyloctenium aegyptium
scindicum
Dalbergia latifolia
sissoo
Dalbergia spp
Dendrocalamus hamiltonii
strictus
Derris indica
Desmodium diffusum
tortuosum
triflorum
Desmostachya bipinnata
Dichanthium annulatum
aristatum
bladhii
caricosum
insculpta
ischaemum
parviflorum
pertusus
Dichrostachys cinerea
Digera muricata
Digitaria ciliaris
longiflora
pentzii
Digitaria sp
Dinebra retroflexa
Diplachne fusca
Drymaria cordata
Echinochloa colona
crusgalli
frumentacea
stagnina
Elaeagnus angustifolia
Elusine indica
Emblica officinalis
Eragrostiella bifaria
Eragrostis ciliaris
gangetica
pilosa
plumosa
superba
tenella
tremula
viscosa
Eremopogon foveolatus
Erythrina indica
Eulalia trispicata
Eulaliopsis binata
Exbucklandia populnea
Fagopyrum esculantum
Farsetia jacquemontii
Ficus beng(h)alensis
glomerata
religiosa
semicordata
Flacourtia indica
Garuga pinnata
Gleditsia triacanthos
Gliricidia sepium
Gloriosa superba
Gmelina arborea
Grewia elastica
tenax
tiliifolia
Hackelochloa granularis
Halopyrum mucronatum
Haloxylon recurvum
Hardwickia binata
Heteropogon contortus
Holoptelea integrifolia
Imperata cylindrica
Indigofera cordifolia
endecaphylla
linifolia
Ipomoea aquatica
muticum
pescaprae
pestigridis
Ischaemum pilosum
rugosum
timorense
Iseilema laxum
prostratum
Juglans regia
Juniperus communis
Kochia indica

  - *prostrata*
  - *scoparia*
- *Kummerowia stipulacea*
- *Kydia calycina*
- *Kyllinga brevifolia*
- *Lablab purpureus*
- *Lannea coromandelica*
- *Lantana camara*
- *Lasiurus hirsutus*
  - *sindicus*
- *Leptadenia pyrotechnica*
- *Leptochloa chinensis*
  - *panicea*
- *Leptothrium senegalensis*
- *Leucaena latisiliqua*
- *Limonia acidissima*
- *Lolium perenne*
- *Lotus corniculatus*
- *Lupinus aungustifolius*
- *Madhuca butyracea*
  - *indica*
  - *longifolia*
- *Mangifera indica*
- *Maytenus emarginata*
- *Medicago hispida*
  - *sativa*
- *Melanocenchris jacquemontii*
- *Melia azedarach*
- *Melilotus alba*
  - *indica*
  - *officinalis*
- *Mimosa hamata*
  - *pudica*
  - *scabrellae*
- *Mitragyna parvifolia*
- *Moringa oleifera*
- *Morus alba*
  - *serrata*
- *Mucuna cochinchinensis*
  - *deeringiana*
  - *pruriens*
- *Narenga porphyrocoma*
- *Neurada procumbens*
- *Ochthochloa compressa*
- *Opuntia dillenii*
  - *elatior*
- *Orinus thoroldii*
- *Ougeinia oojeinensis*
- *Panicum antidotale*
  - *coloratum*
  - *maximum*
  - *meliaceum*
  - *repens*
  - *sumatrense*
  - *trypheron*
  - *turgidum*
  - *virgatum*
- *Parkinsonia aculeata*
- *Paspalum conjugatum*
  - *dialatatum*
  - *notatum*
  - *scorbiculatum*
  - *vaginatum*
- *Pennisetum clandestinum*
  - *orientale*
  - *pedicillatum*
  - *polystachyon*
- *Phacelurus speciosus*
- *Phalaris aquatica*
  - *arundinacea*
- *Phaseolus atropurpureus*
- *Phleum pratense*
- *Phoenix dactylifera*
  - *sylvestris*
- *Phragmites australis*
  - *karka*
- *Pithecellobium dulce*
- *Plantago lanceolata*
- *Pluchea lanceolata*
- *Poa alpina*
  - *compressa*
- *Populus alba*
  - *ciliata*
  - *deltoides*
  - *euphratica*
  - *laurifolia*
  - *nigra*
- *Populus* spp
- *Portulaca oleracea*
- *Portulaca* spp
- *Prosopis alba*
  - *chilensis*
  - *cineraria*
  - *pallida*

tamarugo
Prosopis spp
Prunus cerasoides
Pseudoraphis spinescens
Pterocarpus marsupium
Pueraria lobata
phaseoloides
thomsonii
tuberosa
Randia malabarica
uliginosa
Rhizophora apiculata
mucronata
Rhynchelytrum repens
Rhynchosia minima
Rhynchosia spp
Ricinus communis
Robinia pseudoacacia
Rumex acetosella
Saccharum bengalense
spontaneum
Sacciolepis interrupta
Salicornia brachiata
Salix alba
babylonica
caprea
daphnoides
elegans
fragilis
hastata
tetrasperma
Salsola baryosma
kali
Salvadora oleoides
persica
Salvia aegyptiaca
Samanea saman
Sapium sebiferum
Schleichera oleosa
Scirpus grossus
tuberosus
Scirpus spp
Sehima ischaemoides
Sesbania bispinosa
cannabina
grandiflora
roxburghii
sesban
Simmondsia chinensis
Spergula arvensis
Spinacia oleracea
Sporobolus diander
helvolus
maderaspatanus
marginatus
nervosus
spicatus
Stenotaphrum dimidiatum
Stereospermum suaveolens
Stylosanthes fruticosa
guyanensis
humilis
procumbens
scabra
sundaica
Suaeda fruticosa
maritima
Syzygium cuminii
Tamarindus indica
Tamarix aphylla
Tecomella undulata
Tephrosia purpurea
Terminalia alata
arjuna
bellirica
catappa
Tetrapogon tenellus
Themeda anathera
triandra
Thespesia populnea
Thuarea involuta
Tragus roxburghii
Trema cannabina
orientalis
politaria
Tribulus terrestris
Tricholaena teneriffae
Trifolium alexandrinum
pratense
repens
Tripogon bromoides
Trisetum flavescens
Typha elephantina
Ulex europaeus

Ulmus wallichiana
Urochloa mosambicensis
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Wrightia tinctoria
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Page	Line	For	Read
31	15	species such as	species of
40	10	*Dactyloctenium sindicum*	*Dactyloctenium scindicum*
	21	*A. nuttalli*	*A. nuttalis*
41	6	*Clinogyne dichotoma*	*Donax arundinastrum*
42	11	*P. maximum*	*Panicum maximum*
45	28	i puts	inputs
65	12	plant	plants
86	33	Ergot grows on this grass which...	Ergot,which yields alkaloids, grows on this grass.
112	29	contain	contains
116	23	isused	is used
125	8	handboards	hardboards
132	34	low-lying and flat,	low-lying, flat and
159	20	yield	yielded
166	34	transplanted	transferred
177	1	BOWSTRING OF INDIA	BOWSTRING HEMP OF INDIA
179	25	(Edgew.)Bennet	(Edw.)Bennet
189	17 & 18	*S. mahogany*	*S. mahagony*
195	3 & 4	var. *roseus*	'Roseus'
		var. *alba*	'Alba'
		var. *ocellatus*	'Ocellatus'
196	25	GRAMAGRASS, BLUEPANIC	deleted
201	22 & 23	*C. cenchroides* A.Rich.	deleted
213	27	BEDELLIUM	BDELLIUM
231	39	s	as
232	8	wih	with

Page	Line	For	Read
259	10	*ctiriodora*	*citriodora*
	43	*?R. globoidea*	*? E. globoidea*
288	18	is good	is a good
341	13	*P.* × *euramer ana*	*P.* × *euramericana*
	18	is good	is a good
416	18	ones	once
429	29	Himal	Himal-
447	11	Saha	Shah
450	23	*C. jayabo*	*C. jayabo* Maza
456	3	(1833)	deleted
	10 & 11	*Colocynthis vulgaris* Schrad.(1836) C.B.Clarke (Fl Br Ind) in part	*Citrullus vulgaris* Schrad. ex Eckl. & Zeyh.; C.B.Clarke (Fl Br Ind) in part
	12	*C. citrullus*	*Colocynthis citrullus*
469	18	*tenelle*	*tenella*
470	5	*fovelolatus*	*foveolatus*
481	22	Maki r	Makino
491	20	*ailkamal*	*Nilkamal*
494	14 & 15	*O. corymbosa* DC. *O. maritimus* Zucc. syn.	*O. corymbosa* DC . syn. *O. maritima* Zucc.
499	3	*lanceolota*	*lanceolata*
531	1	*C. glauca*	*C. surattensis*
573	24	*Clinogyne dichotoma*	*Donax arundinastrum*
607	37	*Ipomoea muticum*	*Ischaemum muticum*

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